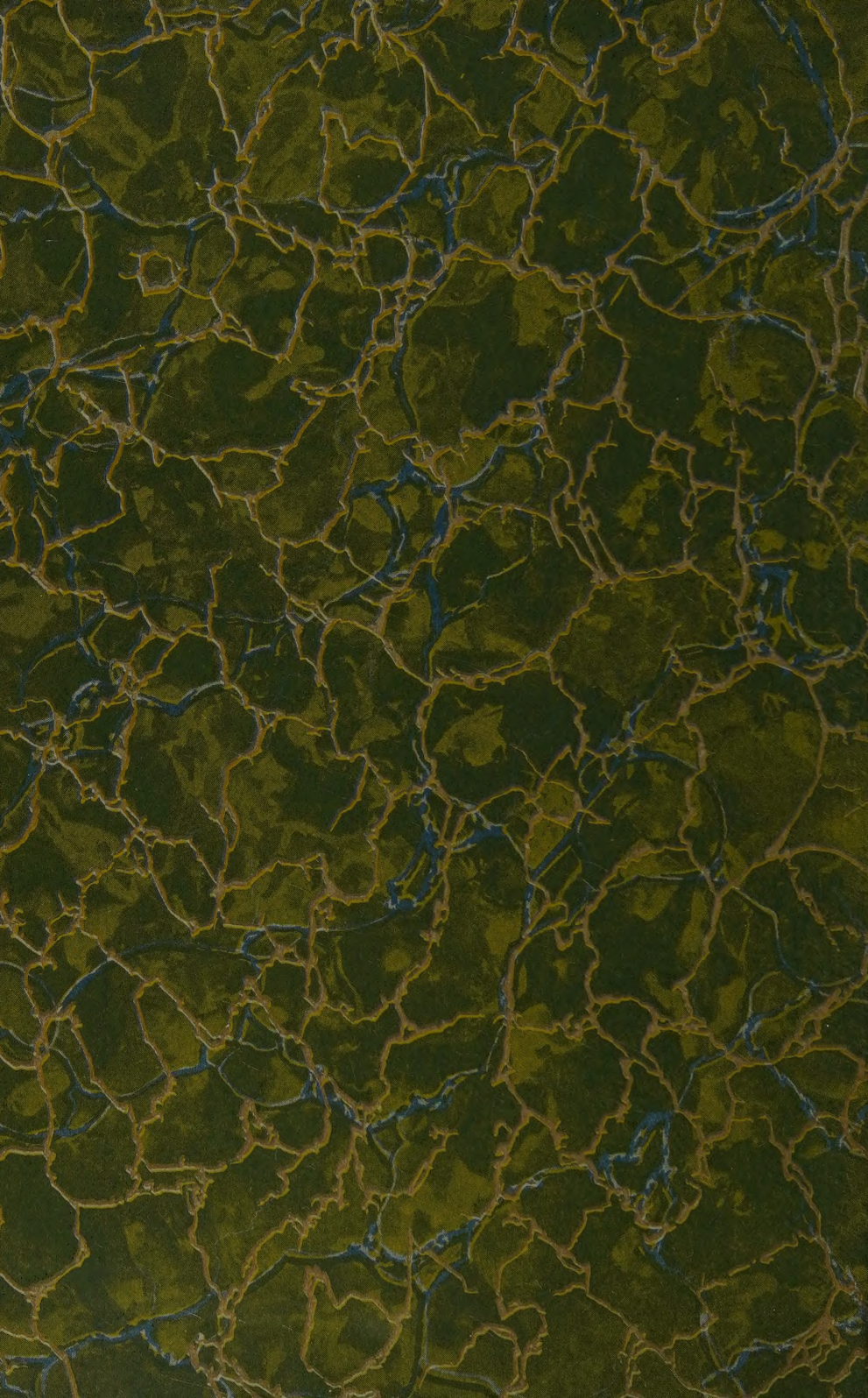
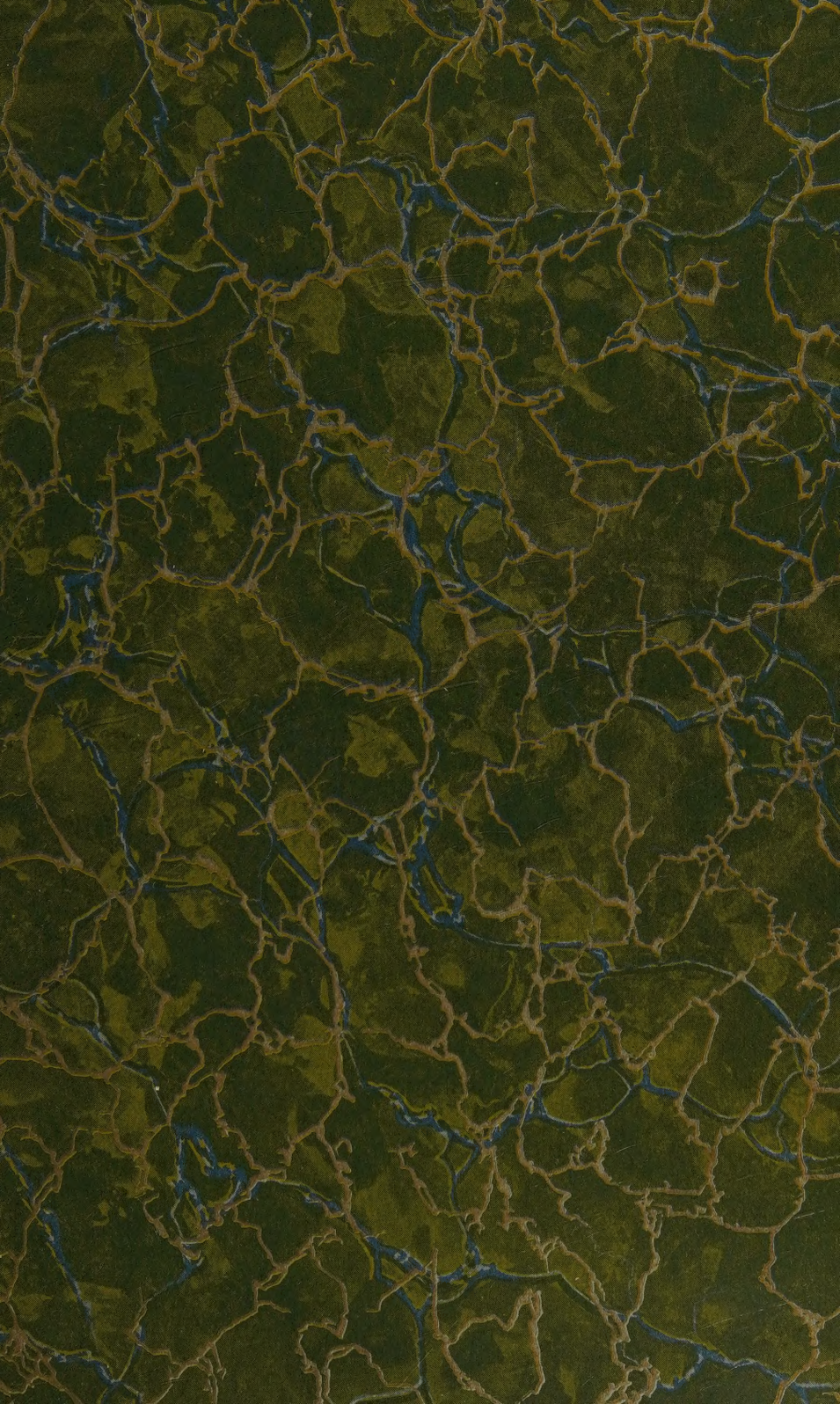
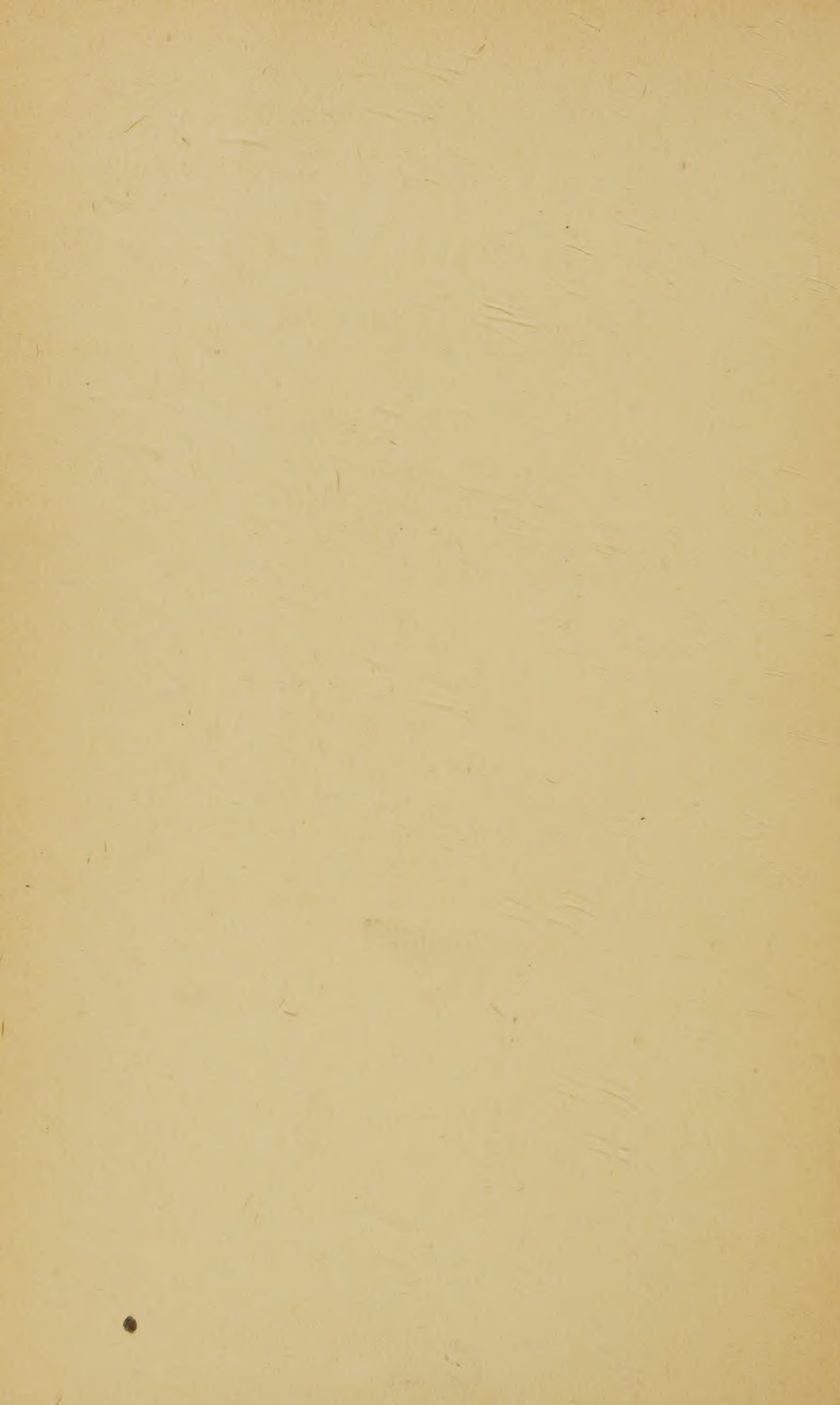






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Drawing for Architects

245 ILLUSTRATIONS

Prepared Under Supervision of
W. S. LOWNDES, Ph.B.

DIRECTOR, SCHOOLS OF ARCHITECTURE AND BUILDING CONSTRUCTION
INTERNATIONAL CORRESPONDENCE SCHOOLS

GEOMETRICAL DRAWING
PROJECTION DRAWING
FREEHAND AND ORNAMENTAL DRAWING
WASH WORK AND BRUSH DRAWING
ELEMENTARY PERSPECTIVE DRAWING
ARCHITECTURAL DRAWING

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GEOMETRICAL DRAWING

DEFINITIONS

1. A **drawing** is a representation of an object on a plane surface by means of simple lines or a combination of lines and shades. When done by the free hand only, it is called **freehand drawing**; when instruments are used, so that exactness may be obtained, it is called **instrumental, or mechanical, drawing**.

2. In **geometrical drawing**, certain expressions are used to represent familiar objects that are not always identical with the terms used in every-day conversation, and terms with which we are familiar ordinarily assume a new and more limited meaning when considered strictly from a geometrical standpoint. For instance, one has a fairly satisfactory idea of a straight line, but, geometrically, a **straight line** is considered as one that has the same direction at every point, as the slightest deviation from one point to another would prevent the line from being straight.

A **curved line** is one that changes its direction by gradual or easy variations at every point.

Any plane (flat) closed figure made up entirely of straight lines is called a **polygon**; see Fig. 8.

A **circle** is a figure bounded by a curved line, every point of which is equidistant from a point within called the **center**, while the curved line bounding the figure is called the **circumference**. Thus, Fig. 1 is a circle because every point of the curved line bounding it, such as *a, b, c*, etc., is equidistant from the center *o*. Any line drawn through a

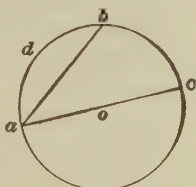


FIG. 1

circle meeting its circumference in two places, as a, b , is called a **chord**, and the part of the circumference between the two ends of a chord, as adb , is called an **arc**. Any chord passing through the center of a circle, as ac , is called the **diameter**. The distance oc or oa is equal to half the diameter and is called the **radius**.

3. In geometrical drawing, circles are drawn with compasses, as explained later. Such expressions as "describe a circle with a radius of 1 inch" or "describe an arc with a radius of 1 inch" mean that the student is to draw with the compasses a circle or an arc whose radius is 1 inch. Any polygon drawn within the circumference of a circle so that all its corners touch that circumference, is said to be **inscribed** within the circle, as in Fig. 2, where the square $abcd$ is inscribed within the circle.

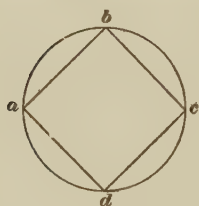


FIG. 2

Any polygon drawn outside of a circle so that all its sides touch the circumference, as shown in Fig. 3, is said to be **circumscribed** about the circle. In the same manner, a circle can be inscribed in, as in Fig. 3, or circumscribed about any regular figure, as in Fig. 2.

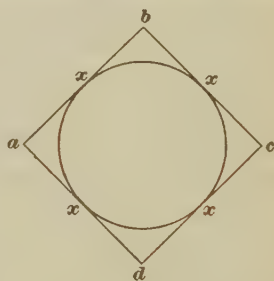


FIG. 3

When a straight line just touches the circumference of a circle without cutting into it as a chord would do, the line is said to be **tangent** to the circumference at that point, as at x in Fig. 3.

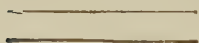


FIG. 4

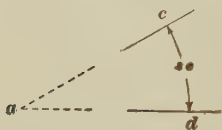


FIG. 5

When two straight lines are equidistant at every point from each other, they are said to be **parallel**, as in Fig. 4; but where they would meet if prolonged, as at a , Fig. 5, they are said to be at an **angle** with each other, and this angle is measured by the arc of a circle struck between

them, as at cd , with its center at the point of intersection a . This point of intersection is called the **vertex** of the angle.

4. For the purpose of measuring angles uniformly, the circumference of a circle is divided into 360 equal parts called **degrees**, as in Fig. 6, and the number of these parts included between any two straight lines, drawn from the center of the circle, measures the number of degrees of that angle, as at ab . It makes no difference what the size of the circle is that is used to measure the angle, since in the larger circle the degree marks would be farther apart and the same number would be included between the diverging straight lines that measure the angle as shown by the arc cd . An angle of 90° representing one-quarter of the circumference of a circle, as at e , Fig. 6, is called a **right angle**. One having less than 90° is called an **acute angle**, and one having more than 90° an **obtuse angle**. A line making an angle of 90° with another line is said to be **perpendicular** to that line. All level lines or lines at right angles to vertical or plumb-lines are called **horizontal lines**.

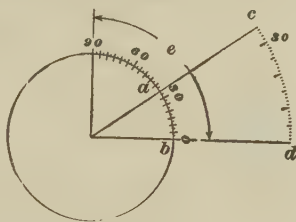


FIG. 6

5. So far nothing has been considered except lines and their relations to each other, but a space bounded by straight or curved lines is called a **surface**. Thus, in the circle,

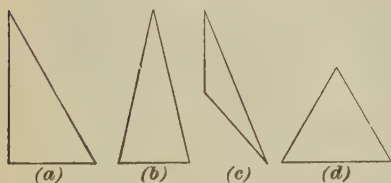


FIG. 7

Fig. 1, its circumference is simply a line, whereas the space enclosed by the circumference is a surface. Figures assume different names according to their forms. One with three

sides is termed a **triangle**, Fig. 7; it may be a right triangle, Fig. 7 (a), an acute triangle, Fig. 7 (b), or an obtuse triangle, Fig. 7 (c), according to its principal angle. Where all three angles and all three sides are equal, it is called an **equilateral triangle**, Fig. 7 (d).

A figure having four sides is called a **quadrilateral**, Fig. 8 (a), (b), and (c). Where each pair of opposite sides is parallel, the figure is called a **parallelogram**, Fig. 8 (a); where the sides are parallel and the angles are right angles, it is called a **rectangle**, Fig. 8 (b); a rectangle whose sides are equal is called a **square**, Fig. 8 (c). Other figures take the names of **pentagon**, as Fig. 8 (d), **hexagon**, Fig. 8

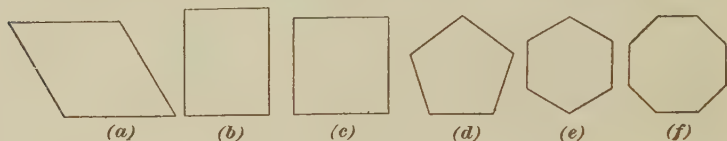


FIG. 8

(e), **octagon**, Fig. 8 (f), etc., according to whether they have five, six, or eight angles and sides, respectively. Figures with more than three sides are generally termed **polygons**. Thus pentagons, octagons, etc. are also polygons. A polygon can have any number of sides. A polygon is said to be regular when all of its sides and angles are equal.

6. Surfaces have only two dimensions, length and breadth, but where an object has a third dimension—thickness—it is called a **solid**. Thus, in Fig. 9, we have a solid whose length a , breadth b , and thickness c are all equal, and

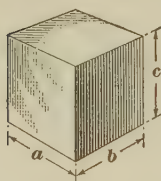


FIG. 9

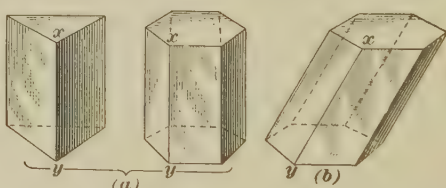


FIG. 10

whose three visible sides are squares; this figure is called a **cube**.

Any figure having a triangle, square, hexagon, or other regular surface for its base, and parallelograms for its sides, as in Fig. 10, is called a **prism**. It is a *right prism* if the parallelograms forming its sides are rectangles, Fig. 10 (a),

and an *oblique prism* if the parallelograms are other than rectangles, Fig. 10 (b). A figure having a circle for a base, and an equal circle for its top with an unbroken surface between, as in Fig. 11, is called a **cylinder**. A figure having any regular polygon for a base and triangles meeting in a point for its sides, as in Fig. 12, is called a **pyramid**; the point where its sides meet is called the **apex**. A figure having a circle for a base and its sides meeting in an apex, as in Fig. 13, is called a **cone**. An imaginary line from the center of the base to the apex or center of the top of any pyramid, cone, prism, or cylinder is called the **axis**.



FIG. 11

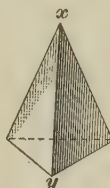


FIG. 12



FIG. 13



FIG. 14



FIG. 15



FIG. 16

imaginary lines called **elements** are used to locate certain points on these figures. xy on Figs. 10 and 12 are angles between the sides of the prisms and pyramid, whereas $x'y'$ on Figs. 11 and 13 are imaginary lines that can be drawn on the surface of the cylinder or cone in order to locate certain points thereon. When the top of a cone or a pyramid is cut off, as in Fig. 14, the lower part of it is called the **frustum** of a cone or pyramid. The line bounding the surface of the top of the frustum of a cone is an **ellipse**.

7. There are three forms of surface that can be obtained by cutting a cone in different directions. These are: (1) the **ellipse**, where the cone is cut through from one side to the other, as in Fig. 14; (2) the **parabola**, where the cone is cut parallel with one side, as in Fig. 15; (3) the **hyperbola**, where the cone is cut parallel to the axis, as in Fig. 16. The parabola and hyperbola are not of much

general importance in design, but the ellipse is frequently made use of.

A solid figure bounded in every direction by a circle is called a **sphere**, and a line through its center being the diameter of its greatest circle is called the diameter of this sphere. Half of a sphere is termed a **hemisphere**.

INSTRUMENTS AND MATERIALS

8. All the **instruments** and **materials** usually required for instrumental drawing are mentioned in the following descriptions:

The **drawing board** should be made of well-seasoned straight-grained pine, the grain running lengthwise. For this Course, the student will need a board of the following dimensions: length over all, about 21 inches; width, about 16 inches.

The drawing board illustrated in Fig. 17 is the one furnished in our students' drawing outfits and can be recommended as meeting all the requirements of the drawing work of this

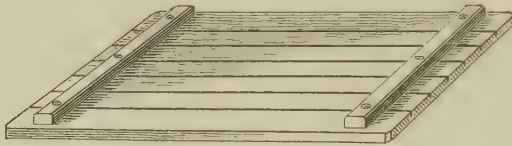


FIG. 17

Course. It is made of several pieces of pine wood glued together to the required width of the board. A pair of hardwood cleats is screwed to the back of the board. Grooves are cut through half the thickness of the board over the entire back side. These grooves take the transverse resistance out of the wood and thus keep the board from warping, at the same time leaving the longitudinal strength nearly unimpaired. The cleats raise the board from the table, thus making it easier to change the position of the board. When in use, the board is placed so that one of the short edges is at the left of the draftsman, as shown in Fig. 18.

The wood of which the board is made is very carefully and thoroughly dried, a necessary precaution to keep the board from

warping. Nevertheless, if kept near a source of heat, as a stove, a radiator, etc., it may warp in spite of the slits, on account of absorbing moisture from the air and the uneven distribution of heat from the stove, radiator, etc.

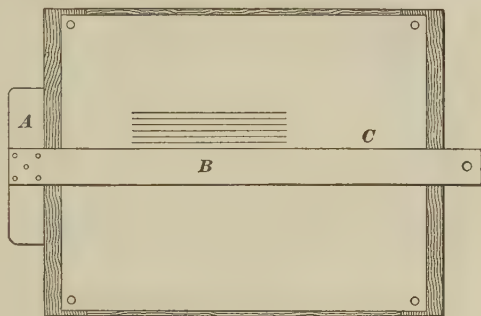


FIG. 18

9. The T square is used for drawing horizontal straight lines. The head *A* is placed against the left-hand edge of the board, as shown in Fig. 18. The upper edge *C* of the blade *B* is brought very near to the point through which it is desired to pass a line, so that the straightedge *C* of the blade may be used as a guide for the pen or pencil. It is evident that all lines drawn in this manner will be parallel.

Vertical lines are drawn by means of **triangles**. The triangles most generally used are shown in Figs. 19 and 20, each of which has one right angle. The triangle shown in

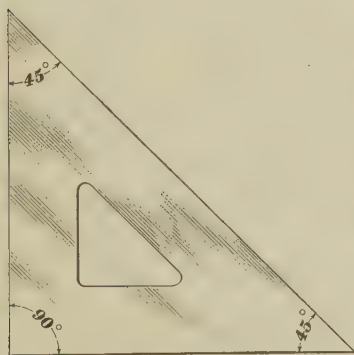


FIG. 19

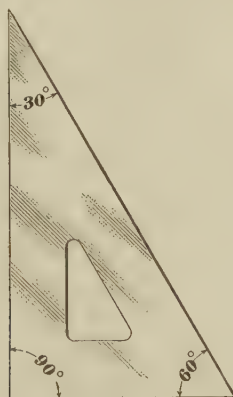


FIG. 20

Fig. 19 has two angles of 45° each, and that in Fig. 20 one of 60° and one of 30° . They are called 45° and 60° triangles,

respectively. To draw a vertical line, place the **T** square in position to draw a horizontal line, and lay the triangle against it, so as to form a right angle. Hold both **T** square and triangle lightly with the left hand, so as to keep them from slipping, and draw the line with the pen or pencil held

in the right hand, and against the edge of the triangle. Fig. 21 shows the triangles and **T** square in position.

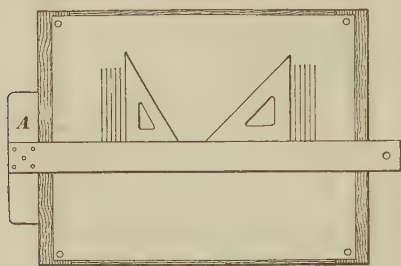


FIG. 21

10. For drawing parallel lines that are neither vertical nor horizontal, the simplest and best way, when the lines are near

together, is to place one edge of a triangle, as ab , Fig. 22, on the given line cd , and lay the other triangle, as B , against one of the two edges, holding it fast with the left hand; then move the triangle A along the edge of B . The edge ab will be parallel to the line cd ; and when the edge ab reaches

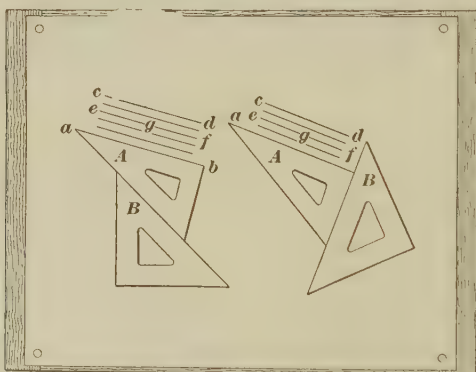


FIG. 22

the point g , through which it is desired to draw the parallel line, hold both triangles stationary with the left hand and draw the line ef by passing the pencil along the edge ab . Should the triangle A extend too far beyond the edge of the

triangle B after a number of lines have been drawn, hold A stationary with the left hand and shift B along to the edge of A with the right hand and then proceed as before.

11. A line may be drawn at right angles to another line which is neither vertical nor horizontal, as illustrated in Fig. 23. Let cd be the given line (shown at the left-hand side). Place one of the shorter edges, as ab , of the triangle B so that it will coincide with the line cd ; then, keeping the triangle in this position, place the triangle A so that its long edge will come against the long edge of B . Now, holding A securely in place with the left hand, slide

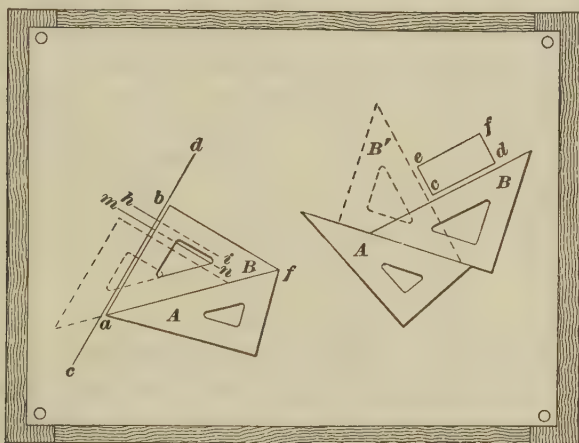


FIG. 23

B along the edge of A with the right hand, when the lines hi , mn , etc. may be drawn perpendicular to cd along the edge bf of the triangle B . The dotted lines show the position of the triangle B when moved along the edge of A .

12. The right-hand portion of Fig. 23 shows another method of accomplishing the same result, and illustrates how the triangles may be used for drawing a rectangular figure, when the sides of the figure make an angle with the T square such that the latter cannot be used.

Let the side cd of the figure be given. Place the *long* side of the triangle B so as to coincide with the line cd , and

bring the triangle *A* into position against the lower side of *B*, as shown. Now, holding the triangle *A* in place with the left hand, revolve *B* so that its other short edge will rest against the long edge of *A*, as shown in the dotted position at *B'*. The parallel lines *ce* and *df* may now be drawn through the points *c* and *d* by sliding the triangle *B* on the triangle *A*, as described in connection with Fig. 22. Measure

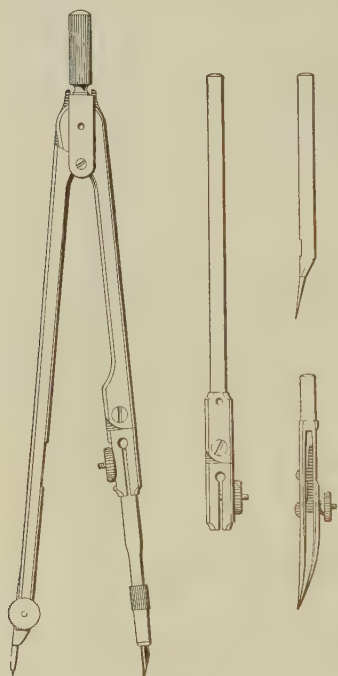


FIG. 24

off the required width of the figure on the line *ce*, reverse the triangle *B* again to its original position, still holding the triangle *A* in a fixed position with the left hand, and slide *B* on *A* until the long edge of *B* passes through *e*. Draw the line *ef* through the point *e*, and *ef* will be parallel to *cd*. The student should practice with his triangles before beginning drawing.

13. The compasses, next to the T square and triangles, are used more than any other instrument. A pencil and pen point are provided, as shown in Fig. 24, either of which may be inserted into a socket in one leg of the instrument, for the drawing of circles in pencil

or ink. The other leg is fitted with a needle point, which acts as the center about which the circle is drawn. In all good instruments, the needle point itself is a separate piece of round steel wire, held in place in a socket provided at the end of the leg. The wire should have a square shoulder at its lower end, below which a fine, needle-like point projects. The lengthening bar, also shown in the figure, is used to extend the leg carrying the

pen and pencil points when circles of large radii are to be drawn.

The joint at the top of the compasses should hold the legs firmly in any position, and at the same time should permit their being opened or closed with one hand. The joint may be tightened or loosened by means of a screwdriver or wrench, which accompanies the compasses.

It will be noticed in Fig. 24 that each leg of the compasses is jointed; this is done so that the compass points may always be kept perpendicular to the paper when drawing circles, as in Fig. 27.

The common style of joint, Figs. 24 and 25, is the *pivot joint*, in which the head of each leg is shaped like a disk and the two disks are held together in a fork-shaped brace either by means of two pivot screws or by one screw penetrating



FIG. 25

both disks. The brace that forms a part of this joint is generally provided with a handle, as the shape of the joint makes it rather awkward to hold the compasses by the head, as is usual with instruments provided with tongue joints. Another common style of compass has what is called a *tongue joint*, in which the head of one leg has a tongue, generally of steel, which moves between two lugs on the other leg. In Fig. 25 is shown a common style of spacing dividers.

14. The following suggestions for handling the compasses should be carefully observed by those who are beginning the subject of mechanical drawing. Any draftsman who handles his instruments awkwardly will create a bad impression, no matter how good a workman he may be. The tendency of all beginners is to use both hands for operating the compasses. This is to be avoided. The student should learn at the start to open and close them with one hand, holding

them as shown in Fig. 26, with the needle-point leg resting

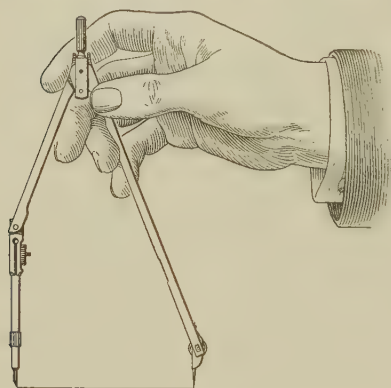


FIG. 26

between the thumb and fourth finger, and the other leg between the middle and forefinger. When drawing circles, hold the compasses lightly at the top between the thumb and forefinger, or thumb, forefinger, and middle finger as in Fig. 27. Another case where both hands

should not be used is in locating the needle point at a point on the drawing about

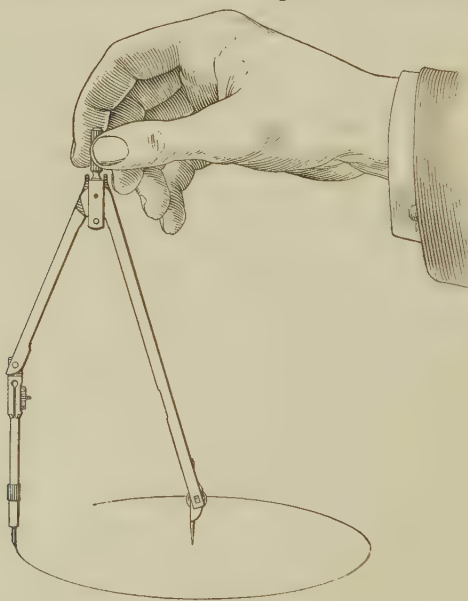


FIG. 27

which the circle is to be drawn, unless the left hand is used merely to steady the needle point. Hold the compasses as

shown in Fig. 26, and incline them until the under side of the hand rests on the paper. This will steady the hand so that the needle point can be brought to exactly the right place on the drawing. Having placed the needle at the desired point, and with it still resting on the paper, the pen or pencil point may be moved out or in to any desired radius, as indicated in Fig. 26. When the lengthening bar is used, both hands must be employed.

15. The compasses must be handled in such a manner that the needle point will not dig large holes in the paper. Keep the needle point adjusted so that it will be perpendicular to the paper, when drawing circles, and do not bear on it. A slight pressure will be necessary on the pen or pencil point, but not on the needle point.

16. The **dividers**, shown in Figs. 25 and 28, are used for laying off distances on a drawing, or for dividing

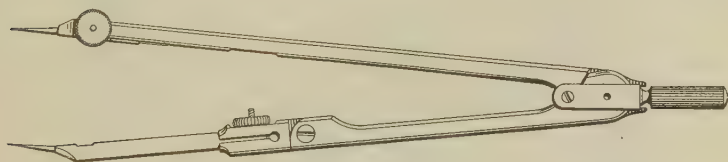


FIG. 28

straight lines or circles into parts. The points of the dividers should be very sharp, so that they will not punch holes in the paper larger than is absolutely necessary to be seen. Compasses are sometimes furnished with two steel divider points, besides the pen and pencil points, so that the instrument may be used either as compasses or dividers. This is the kind illustrated in Fig. 28. When using the dividers to space a line or circle into a number of equal parts, hold them at the top between the thumb and forefinger, as when using the compasses, and step off the spaces, turning the instrument alternately to the right and left. If the line or circle does not space exactly, vary the distance between the divider points and try again; so continue until it is spaced equally. When spacing in this manner, great care

must be exercised not to press the divider points into the paper; for, if the points enter the paper, the spacing can never be accurately done. The student should satisfy himself of the truth of this statement by actual trial.

17. The **bow-pencil** and **bow-pen**, shown in Fig. 29, are convenient for describing small circles. The two points of the instruments must be adjusted to the same length; otherwise, very small circles cannot be drawn. To open or close either of these instruments, support it in a vertical position by resting the needle point on the paper and bear-

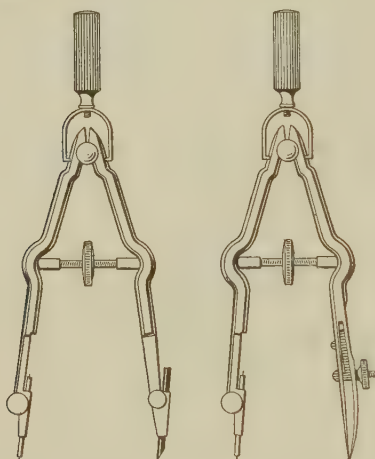


FIG. 29



FIG. 30

ing slightly on the top of it with the forefinger of one hand, and turn the adjusting nut with the thumb and middle finger of the same hand.

18. Drawing Paper and Pencils.—The drawing paper recommended for this series of lessons is the Technical Supply Company's brown detail, in sheets 10" $\times$ 15". It takes ink well and withstands considerable erasing. The paper is secured to the drawing board by means of **thumb-tacks**. Four are usually sufficient—one at each corner of the sheet (see Fig. 23). Place a piece of paper on the drawing board, and press a thumbtack through one of the corners

about $\frac{1}{4}$ or $\frac{3}{8}$ inch from each edge. Place the **T** square in position for drawing a horizontal line, as before explained, and straighten the paper so that its upper edge will be parallel to the edge of the **T**-square blade. Pull the corner diagonally opposite that in which the thumbtack was placed, so as to stretch the paper slightly, and push in another thumbtack. Do the same with the remaining two corners. For drawing in pencil, an HH pencil of any reputable make should be used. The pencil should be sharpened as shown in Fig. 30. Cut the wood away so as to leave about $\frac{1}{4}$ or $\frac{3}{8}$ inch of the lead projecting, and sharpen it by rubbing it against a fine file or a piece of fine emery cloth or sandpaper that has been fastened to a flat stick. Do this frequently so as to keep a sharp point throughout each exercise. The lead for the compasses should be sharpened in the same manner as the pencil except that its edge should be chisel-shaped, so that it will wear down slowly.

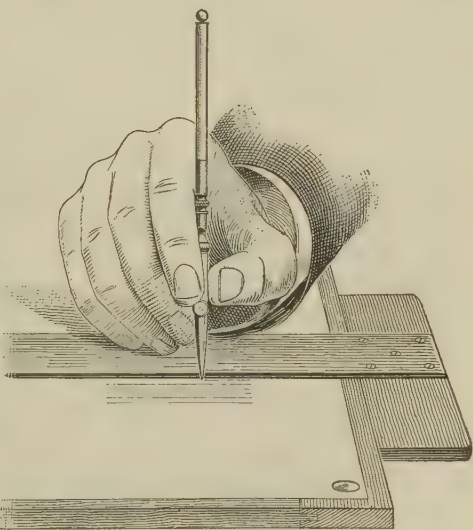


FIG. 31

Be sure that the compass lead is so secured that, when circles are struck in either direction, but one line will be drawn with the same radius and center.

19. Inking.—For drawing ink lines other than arcs of circles, the **ruling pen** (or *right-line pen*, as it is sometimes called) is used. It should be held as nearly perpendicular to the board as possible, with the hand in the position shown in Figs. 31 and 32, bearing lightly against the **T** square or triangle, along the edge of which the line is drawn.

After a little practice, this position will become natural, and no difficulty will be experienced.

20. The beginner will find that it is not always easy to make smooth lines. If the pen is held so that only one blade bears on the paper when drawing, the line will almost invariably be ragged on the edge where the blade does not bear. When held at right angles to the paper, as in Fig. 32, however, both blades will rest on the paper, and if the pen is in good condition smooth lines will result. The pen must not be pressed against the edge of the T square or

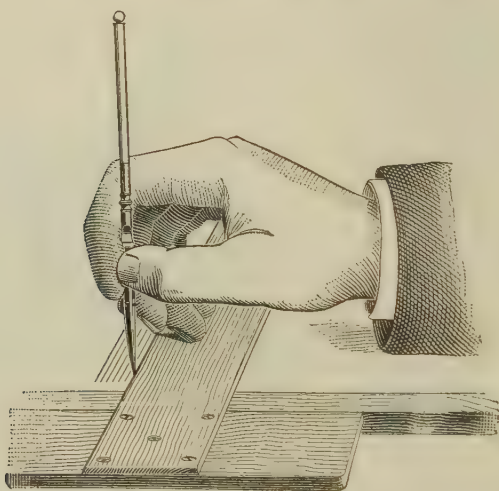


FIG. 32

triangle, as the blades will then close together, making the line uneven. The edge should serve as a guide simply.

In drawing circles with the compass pen, the same care should be taken to keep the blades perpendicular to the paper by means of the adjustment at the joint. In both the ruling pen and compass pen, the width of the lines can be altered by means of the screw that holds the blades together. The handles of most ruling pens can be unscrewed, and are provided with a needle point intended for use when copying maps by pricking through the original and the

underlying paper, thus locating a series of points through which the outline may be drawn.

21. Drawing Ink.--The ink we recommend for the work in this Course is the Technical Supply Company's superior waterproof liquid India ink. A quill is attached to the cork of every bottle of this ink, by means of which the pen may be filled. Dip the quill into the ink and then pass the end of it between the blades of the drawing pen. Do not put too much ink in the pen, not more than enough to fill it for $\frac{1}{4}$ inch along the blades, otherwise the ink is liable to drop. Many draftsmen prefer to use stick India ink; and for some purposes this is to be preferred to the prepared liquid ink recommended above. In case the stick ink is bought, put enough water in a shallow dish (a common individual butter plate will do) to make enough ink for the drawing, then place one end of the stick in the water, and grind by giving the stick a circular motion. Do not bear hard on the stick. Test the ink occasionally to see if it is black. Draw a fine line with the pen and hold the paper in a strong light. If it shows brown (or gray), grind a while longer, and test again. Keep grinding until a fine line shows *black*, which will usually take from 15 minutes to $\frac{1}{2}$ hour, depending on the quantity of water used. The ink should always be kept well covered with a flat plate of some kind, to keep out the dust and prevent evaporation. The drawing pen may be filled by dipping an ordinary writing pen into the ink and drawing it through the blades, as previously described when using the quill. If liquid ink is used, all the lines on all the drawings will be of the same color, and no time will be lost in grinding. If stick ink is used, it is poor economy to buy a cheap stick. A small stick of the best quality, costing, say, a dollar, will last as long, perhaps, as five dollars' worth of liquid ink. The only reason for using liquid ink is that all lines are then sure to be of equal blackness and time is saved in grinding.

India ink will dry quickly on the drawing, which is desirable, but it also causes trouble by drying between the blades

and refusing to flow, especially when drawing fine lines. The only remedy is to wipe out the pen frequently with a cloth. Do not lay the pen down for any great length of time when it contains ink; wipe it out first. The ink may sometimes be started by moistening the end of the finger and touching it to the point, or by drawing a slip of paper between the ends of the blade. *Always keep the bottle corked.*

22. Irregular Curves.—Curves other than arcs or circles are drawn with the pencil or ruling pen by means of curved or irregular-shaped rulers, called **irregular curves** (see Fig. 33). A series of points is first determined through which the curved line is to pass. The line is then drawn through these points by using such parts of the irregular curves as will pass through several of the points at once, the curve being shifted from time to time as required.



FIG. 33

It is usually difficult to draw a smooth, continuous curve. The tendency is to make it curve out too much between the points, thus giving it a wavy appearance, or else to cause it to change its direction abruptly where the different lines join, making angles at these points. These defects may largely be avoided by always fitting the curve to at least three points, and, when moving it to a new position, by setting it so that it will coincide with part of the line already drawn. It will be found to be a great help if the line be first sketched in freehand, in pencil. It can then be penciled over neatly, or inked, without much difficulty, with the aid of the irregular curve, since the original pencil line will show the general direction in which the curve should be drawn. Whenever the given points are far apart, or fall in such positions that the irregular curve cannot always be made to pass through three of them, the line must invariably be sketched in at first.

As an example, let it be required to draw a curved line through the points a, b, c, d , etc., Fig. 34. As just stated, a part of the irregular curve must be used that will pass through at least three points. With the curve set in the first position A , its edge is found to coincide with four points a, b, c , and d . The line may then be drawn from a around to d , or, better, to a point between c and d , since, by not con-

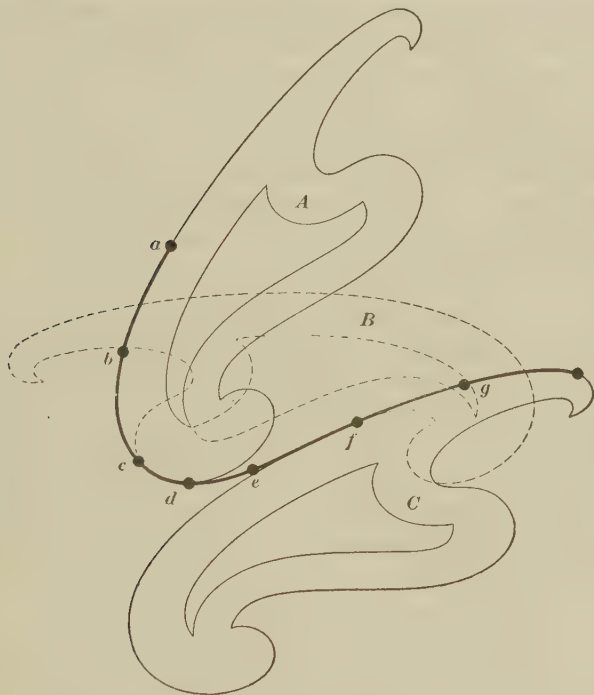


FIG. 34

tinuing it quite to d , there is less liability of there being an angle where the next section joins on. For the next section of the line, the curve should be adjusted so as to coincide with a part of the section already drawn; that is, instead of adjusting it to points d, e, f , etc., it should be placed so as to pass through the point c , the part from c to d being coincident with the corresponding part of the first line drawn. The irregular curve is shown dotted in this position at B . Its edge

passes through four points *c*, *d*, *e*, and *f*, and the line should be made to stop midway between the last two, as before.

Now, it will be noticed that the points *f* and *g* are so situated that the remainder of the line must curve up, instead of down, as heretofore, the change in curvature occurring at a point between *e* and *f*. In this case, therefore, it is not necessary for the curve to extend back to *e*, through which point the line has already been drawn, but it may be placed in position *C* with its edge just tangent to the line at the point where the curvature changes.

It is to be noticed that in inking with the irregular curve the blades of the pen must be kept tangent to its edge (i. e., the inside flat surface of the blades must have the same direction as the curve at the point where the pen touches the paper), which requires that the direction of the pen be continually changed.

23. The scale is used for obtaining measurements for drawings. The most convenient forms are the usual flat and triangular boxwood scales, having beveled edges, each of which is graduated for a distance of 12 inches. The beveled edges serve to bring the lines of division close to the paper when the scale is lying flat, so that the drawing may be accurately measured, or distances laid off correctly. The use of the graduations on scales will be explained when it is necessary to use the scale.

LETTERING

24. In instrumental drawing, all headings, explanatory matter, and dimensions should be neatly printed on the drawing. Ordinary script writing is objectionable.

It is usually difficult for beginners to letter well, and unless the student is skilful at it he should devote some time to practicing lettering before commencing the drawing. In correcting the plates, the lettering will be considered as well as the drawing. Many students think that it is only necessary to exercise special care when drawing the views on a plate, and that it is not necessary to take particular

pains in lettering. This, however, is not the case, for, no matter how well the views may be drawn, if the lettering is poorly done, the finished drawing will not have a neat appearance. In fact, generally speaking, more time is required to make well-executed letters than to make well-executed drawings of objects. We earnestly request the student to practice lettering, and not to think that that part of the work is of no importance. The student should not be too hasty in doing the lettering. It takes an experienced draftsman considerable time to do good lettering, and no draftsman can perform this work as quickly as he can ordinary writing; therefore, no beginner should attempt to do what experienced draftsmen cannot do. In order to letter well, the work must be done slowly. Very frequently more time is spent in lettering a drawing than in inking in the objects represented. Instructions will be given in two

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz &
1234567890 1234567890 2'-6½" dia. Cast Iron

FIG. 35

styles of freehand lettering, both extensively used in American drafting rooms.

With the exception of the large headings or titles of the plates, the style and size of all lettering used on the original drawing plates of this Section are shown in Fig. 35. This style, although a little more elaborate and difficult in execution than that shown in Fig. 39, is recommended on account of its greater neatness and legibleness. The two styles are very similar in the formation of the letters, and although the student is advised to select and use only one of the two on his drawings in this Section, he will find, after having mastered one of the styles, little difficulty in practicing the other.

When lettering, a Gillott's No. 303 pen should be used. The height of the capital letters should be $\frac{3}{32}$ inch, and of the small letters two-thirds of this, or $\frac{1}{16}$ inch. This applies to both styles of freehand lettering. Do not make them larger than this.

25. Before beginning to letter, horizontal guide lines should be drawn with the **T** square, to serve as a guide for the tops and bottoms of the letters (see Fig. 36). The outside lines should be $\frac{3}{32}$ inch apart for the capitals, and the two lower lines $\frac{1}{16}$ inch apart for the small letters. The letters should be made to extend fully up to the top, and down to the bottom, guide lines. They must not fall short of the guide lines, nor extend beyond them. Failure to observe this point will cause the lettering to look ragged, as in the second word in Fig. 36.

FIG. 36

26. It is very important that all the letters have the same inclination. For example, by referring to Fig. 37 (a), it will be seen that the backs of letters like *B, E, l, g, d, i, t*, etc. are parallel and slant the same way. This is also true of both sides of letters like *H, M, n, u, h, y*, etc. To aid in keeping the slant uniform, draw parallel slanting lines across the guide lines with the 60° triangle, as in Fig. 37 (b), and, in lettering, make the backs or sides of the letters parallel with these lines.

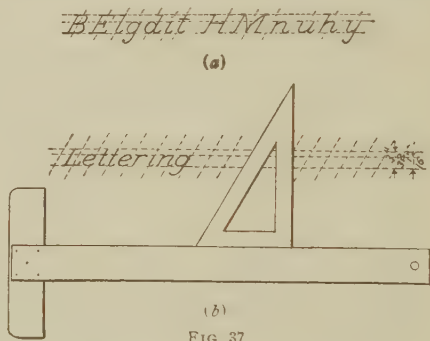


FIG. 37

27. A few points regarding the construction of the letters are illustrated in Fig. 38, in which the letters are shown on an enlarged scale. The capital letters *A, V, Y, M*, and *W* must be printed so that their general inclination will be the same as for the other letters. To print the *A*, draw the center line *ad*, having the common

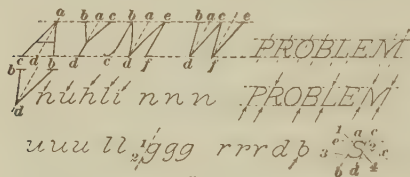


FIG. 38

slant; from a draw the sides ac and ab , so that the points c and b will each be $\frac{3}{8}$ inch distant from point d . The side ab will be nearly perpendicular to the guide lines. The V is like an inverted A , and is drawn in the same way, the line bd being nearly perpendicular.

To make the Y , draw the center line ad , having the common slant, which gives the slant for the base of the letter. The upper part of the Y begins a little below its center, and is similar to the V , though somewhat narrower, as the letter should be only $\frac{5}{8}$ inch wide at the top. Points b and c should be at equal distances from point a .

The two sides bc and ef of the M are parallel, and have the common slant. The M is made as broad as it is high, or $\frac{3}{2}$ inch. Having drawn the two sides, mark the point d , midway between the points c and f , and connect it with points b and e . The lines bd and ed should be slightly curved, as shown.

In the W , the two outside lines are not parallel, as in the M , but are farther apart at the top than at the bottom. Draw the line ad , having the common slant. Mark points b and c , which are exactly $\frac{1}{2}$ inch from the point a . From b and c , draw lines bd and cd . The other half of the W is like the first part, cf being parallel to bd and ef parallel to cd . It will be seen that the W is composed of two narrow V 's, each $\frac{1}{8}$ inch wide, the width of the whole letter being $\frac{1}{2}$ inch.

28. Capital letters like P, R, B, L, E , etc. should be printed so that their top and bottom lines will be exactly horizontal. This is illustrated in the two examples of the word *PROBLEM* in Fig. 38. In the first example, it will be noticed that the tops of the P and R , the bottom of the L , and the tops and bottoms of the B and E , all run in the same direction as the guide lines, and coincide with them. In the second example, these lines are not horizontal, which makes the word look very uneven. It is also to be noticed that these lines extend beyond the upright lines in the first word, and that cross-lines are used on the bottom of the P and R , on the top of the L , and on the M . In the second word,

these lines are omitted at the points indicated by the arrows. These features are found on most of the other capitals.

The small letters *n, u, h, l, i*, etc. should have sharp corners at the points indicated by the arrows in Fig. 38. They look much better that way, and are less difficult to make, than when they have round corners. Following these letters are five groups of letters containing *n, u, l, g*, and *r*. The first letter of each group is printed correctly, while the letters following show ways in which they should *not* be printed. In the case of the *g*, point 2 should fall in a slanting direction under point 1, the slant being the same as *ad* of the preceding letters. The difference between *d* and *b* and the construction of the *s* are also shown in the same figure. The *b* should be made rounding at the point indicated. As a guide in making the *s*, draw the two lines *ab* and *cd*, having the common slant. The *s* should now be drawn so that it will touch these lines at points 1, 3, and 4, but *not* at point 2. It will be an additional help if the line *ex* is also drawn as a guide for the middle portion of the *s*; but care should be taken not to have it slant more than shown in the copy.

The letters *a, o, b, g*, etc. should be full and round; do not cramp them. It will be necessary to follow the copy closely until familiar with it. Notice that the figures are not made as in writing, particularly the 6, 4, 8, and 9 (see Fig. 35). Try to space the letters evenly. Letter in pencil first, and, if not right, erase and try again.

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz&

1234567890 1234567890 2'-6 $\frac{1}{4}$ " dia. Cast Iron

FIG. 39

29. Another style of freehand lettering is shown in Fig. 39. This style is extensively used for the lettering of working drawings. It is more easily and rapidly made than the style previously described, and although not productive

of as high degree of neatness in appearance will be found very useful and acceptable for general office work.

A comparison between the two systems will disclose a great similarity in the detail formation of the letters.

30. The horizontal and slanting guide lines are drawn exactly in the same manner as for the style previously described, and if

Horizontal Horizontal

FIG. 40

not followed, the results will be similar. See the uneven appearance of the second word in Fig. 40.

31. By studying the formation of the letters carefully, it will be found that many of them are formed on the same principle, as shown in Fig. 41.

The ovals of the letters *a*, *b*, *d*, *g*, *p*, and *q* are formed exactly alike and have a slant of 45° with the horizontal.

a b d p q o

c e

r n m h

w v y

tl jf

FIG. 41

These ovals should be made a little wider at the top than at the bottom.

Care should be taken that the straight downward strokes are made parallel to the slanting guide lines. The letters *c* and *e* are commenced in the same way, but the upper loop in *e* should be formed in such a manner that its axis will be at an angle of 45° with the horizontal. The *r* is

made by having the down stroke parallel to the slanting guide line and the up stroke slightly curved in the same way as in the letter *n* (see Fig. 41). The strokes in the letters *j* and *f* are the same, with the position of the hook part reversed.

32. The capital letters shown in Fig. 42 are formed very nearly in the same manner as those shown in Art. 27, but differ slightly by omitting the short spurs that give to the letters a more finished appearance.

A Y M W

V PROBLEM

FIG. 42

In the capital *M*, however, there is a decided variation. The *M* is made with four strokes, putting in the parallel sides first. The two other strokes should join midway between these sides and at a distance from the top of about four-fifths of the height of the letter. These strokes, as will be seen, are straight and not curved.

33. The *numerals* should be $\frac{3}{32}$ inch high and of the style shown in Fig. 39; fractions should be $\frac{1}{8}$ inch high over all.

1 2 3 4 5 6 7 8 9 0

FIG. 43

In Fig. 43, the numerals are illustrated to a larger scale, and a comparison with the style shown in Fig. 35 will disclose several variations.

The loops of the 2, 3, 5, 6, and 9 should be formed so that their axes will be at an angle of 45° with the horizontal. It will be noted that the 7 differs widely from the style shown in Fig. 35, the down stroke not curving but having a straight slant of 45° . The axis of the 0 and the loops of the 8 should slant at an angle of 60° .

Diligent practice for a short time and careful observation of the forms of letters and numerals, as shown in Figs. 35 to 43, will soon enable the student to acquire skill and speed in this branch of drawing.

34. The alphabet shown in Fig. 44 is characteristic of the lettering that is generally used in the offices of architects, and may be used, if desired, in lettering the sheets in Geometrical Drawing. The student should diligently practice making these letters, doing them freehand both with pencil and with pen and ink.

In practicing, the letters of this alphabet should be drawn at the heights shown in Fig. 44. The widths will vary with the shapes of the letters. The letters *C*, *D*, *G*, *O*, and *Q* will be approximately the same in width as in height. This will give a round, full effect to these letters. The letters *L*, *N*, *X*, and *Y* are about as wide as they are high. More width

A B C D E F G H

I J K L M N O P Q

R R S S T U V W W

X Y Z & & 9 X X

A B C D E F G H I J K L M N O P

Q R R S S T U V W W X Y Z &

9 & X X 1 2 3 4 5 6 7 8 9 0 $\frac{1}{2}$ $\frac{3}{8}$

A B C D E F G H I J K L M N O P Q R R S S T U W W

X X X Y Z 1 2 3 4 5 6 7 8 9 0 $\frac{3}{16}$ $\frac{5}{8}$ ALPHABI

a a b c d e f g h i j k l m n o p q r s t u v w x

x y z etc one quarter inch scale e

THIS STYLE OF LETTERING FOR

RAPID LETTERING ON PLANS &

is required for the letters *W* and *M* due to their peculiar shapes. The letter *I* is naturally a very narrow letter and care must be exercised in using this letter not to place other letters too close to it so as to crowd it.

These letters should be drawn freehand. The larger letters should be made with a falcon or a ball-pointed pen. The smaller letters may be made with a Gillott's No. 303. The lines should be made firmly and of even thickness. Each vertical and horizontal line should be made with one firm stroke. The same is true of the curves. Thus, the letter *A* is made with five strokes, two for the slanting sides, one for the horizontal line at the middle, and two for the short lines at the bottoms of the side lines. These short lines are known as **ceriphs** and add a great deal to the character of the letters. They are also shown in the letters in Fig. 35. Ceriphs are also shown in the small letters in Fig. 44.

Circular letters such as *O* are made in two strokes, one for each vertical half of the letter. The letter *S* should be formed in one stroke so as to form a beautiful curve. As in the lettering already described, horizontal guide lines should be drawn at the top and bottom of each word or line of words. Each letter should touch both lines or the lettering will look ragged. The horizontal lines at the top and bottom of each letter should lie in these guide lines. The tops of curved letters such as *O* and *C* should extend slightly above and below the guide lines, otherwise they will not look high enough.

Uniformity in inclination should be maintained as already described and slanting guide lines may be used when practicing lettering.

The distance between letters should be such that there will be no gaps or openings in the words, and that the letters shall not be crowded together. This is illustrated in Fig. 44.

35. In order that the student may become familiar with the forms and proportions of these letters, he will execute, in pencil, for criticism a complete sheet of letters as given in Fig. 44, drawn as a separate exercise on a sheet of paper

9"×12", and send it in with his first exercise in geometrical drawing. Guide lines, both horizontal and inclined, should be used and should not be erased from the sheet. A horizontal guide line may be drawn midway between the top and bottom guide line to locate the horizontal lines in letters such as *E*, *F*, *G*, and *H*.

Too much stress cannot be laid upon the importance of good lettering. The mastery of this subject at this time will save time in the future.

36. The exercises in this Section are each to be executed on several sheets according to the printed instructions in the following pages. Each sheet of the exercises will be 9"×12", outside measurement, with a border line $\frac{1}{2}$ " within the edge, except at the top, where the border will be $\frac{3}{4}$ " within the edge, thereby leaving the working space on each sheet $7\frac{3}{4}$ "×11". The problems are to be arranged as directed, and the entire work on each sheet should be completed in pencil before any of it is inked in.

When all the sheets of the first exercise are finished, they should be mailed to us at one time in one of the large envelopes provided for that purpose.

While we are correcting Exercise I, you are to proceed with the problems in Exercise II. In the meantime we will return your Exercise I to you. On receiving back Exercise I from us, you should note carefully all corrections and suggestions that may be sent with it. You will make better progress if you do not send us a new exercise until you have received back the last one and have had an opportunity to note our corrections and suggestions.

It is very essential that you strictly comply with these directions; since, otherwise, it will be impossible for us to point out your mistakes to you. This procedure should be strictly adhered to while you are drawing the first exercises of the Course—it will enable you to make rapid progress. Do not be

discouraged if there are a large number of corrections on your early exercises; we are merely pointing out ways in which the drawing or lettering can be improved so that your later exercises may be as nearly perfect as they can be made. No one can attain proficiency unless the work is criticized, and we are doing our best to help you succeed; we should not be doing our duty if we did not point out the defects. The *number* of corrections is no indication of our appreciation of the merits of the drawing.

On all exercises that you send to us, place your name and address in full on the back of the first sheet of each exercise, besides placing the date, name, and class letters and number below the margin on the face of each sheet as hereinafter directed. This should in no case be omitted, as delay in the return of your work will otherwise surely occur.

EXERCISES

37. Preliminary Directions.—Each exercise will be executed on from three to six sheets, each sheet being $9'' \times 12''$ over all and having a border line $\frac{1}{2}''$ from each edge, except at the top, where the border will be $\frac{3}{4}''$, thus making the space on which the drawing is to be made $7\frac{3}{4}'' \times 11''$. The sheet at first must be larger than this, so that the thumbtack holes may be cut out; the extra margin is also very convenient, when any work requires inking, for testing the pen, in order to see whether the ink is flowing well and whether the lines are of the proper thickness.

The first exercises will consist of practical geometrical problems that constantly arise in practice when laying out plans and designs. The method of solving each of these problems should be carefully memorized, so that it can be instantly applied when the occasion requires, without being obliged to refer to the text for help. Particular attention should be paid to the lettering. Whenever any dimensions are specified, they should be laid off as accurately as possible.

All drawings should be made as neatly as possible, and the penciling entirely finished before inking in any part of it. Great care should be taken in distributing the different views, parts, details, etc. on the drawing, so that when the drawing is completed, one view will not be so near to another as to mar the appearance of the drawing. The hands should be perfectly clean, and should not touch the paper except when necessary. No lines should be erased except when absolutely necessary; for, whenever a line has once been erased, the dirt flying around in the air and constantly falling on the drawing will stick to any spot where an erasure has been made, and it is then very difficult, if not impossible, to entirely remove it. Hence, all lines that are to be removed, or are liable to be changed, should be drawn lightly, that the surface of the paper may not be injured when erasing them. When it is desired to erase an ink blot or a line that has been inked in, use an *ink eraser* or *sand rubber*. Do not use a knife. After the erasure has been made, the roughened part of the surface of the paper can be smoothed by rubbing with some hard, smooth substance, as a piece of ivory or the handle of a knife.

EXERCISE I

38. Fasten a sheet of drawing paper to the board, as previously described, and draw the outlines of the size of the plate $9'' \times 12''$. Draw the border line all around inside of the edge, leaving the space inside for the drawing $7\frac{3}{4}'' \times 11''$. Where the word *drawing* is used hereafter, it refers only to the space inside the border lines and the objects drawn on it. Study carefully the full-page illustration on Sheet I, which shows, on a smaller scale, exactly how your first drawing should look when completed. Divide the space within the border line into two rectangles by a vertical line through the center. Within these rectangles arrange each figure appropriately spaced. On the first five exercises, space for the lettering must be taken into account. For each of the sheets, the lettering will take up one or two lines. The

height of all capital letters on these plates will be $\frac{3}{8}''$, and of the small letters two-thirds of this, or $\frac{1}{6}''$. The distance between any two lines of lettering will also be $\frac{3}{8}''$. The distance between the tops of the letters on the first line of lettering and the top border line of the drawing is to be about $\frac{5}{8}''$. This makes a very neat arrangement, if the figure is so placed that the outermost points of the bounding lines are equally distant from the sides of one of the equal rectangular spaces. The letter heading for each figure will be printed in heavy-faced type at the beginning of the directions explaining each problem. The student must judge for himself by the length of the heading whether it will take up one line or two, and make due allowance for the space it takes up. This is a necessary precaution, because the lettering should never be done *until the rest of the drawing is entirely finished and inked in*.

PROBLEM 1.—To bisect a straight line.

See Exercise I, Sheet I.

CONSTRUCTION.—Draw a straight line AB , $4\frac{1}{2}''$ long. With one extremity A as a center, and a radius greater than one-half of the length of the line, describe an arc of a circle on each side of the given line; with the other extremity B as a center, and the same radius, describe arcs intersecting the first two in the points C and D . Join C and D by the line CD , and the point P , where it intersects AB , will be the required point; that is, $AP = PB$, and P is the middle point of AB . Since CD is perpendicular to AB , this construction also gives a *perpendicular to a straight line at its middle point*.

PROBLEM 2.—Through a given point, to draw a straight line parallel to a given straight line.

See Exercise I, Sheet I.

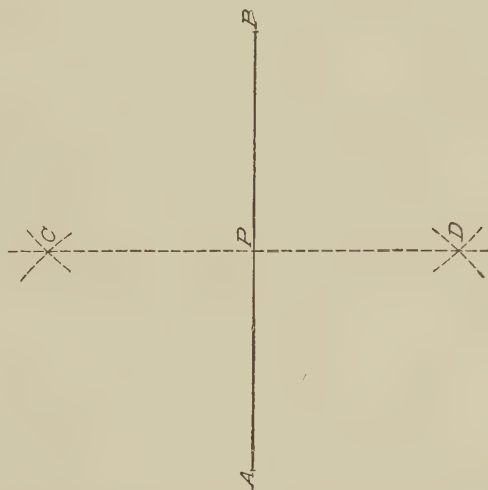
CONSTRUCTION.—Let P be the given point, and AB the given straight line $4\frac{1}{2}''$ long. With P as a center, and any convenient radius, describe an arc CD intersecting AB in D . With D as a center, and the same radius, describe the

Geometrical Drawing

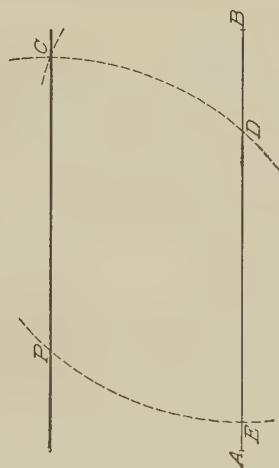
Exercise I.

Sheet I.

PROBLEM 1: To bisect a straight line.



PROBLEM 2: Through a given point to draw a straight line parallel to a given straight line.



Date

Time consumed in
executing this sheet

Name of student, Class letters
and Number

arc PE . With D as a center, and a radius equal to the chord of the arc PE , describe an arc intersecting CD in C . A straight line drawn through P and C will be parallel to AB .

PROBLEM 3.—To draw a perpendicular to a straight line from a given point in that line.

NOTE.—As there are two cases of this problem, requiring two figures on the sheet, the line of letters will be run clear across both figures, as shown in Exercise I, Sheet II.

CASE I.—*When the point is at or near the center of the line.*

See Exercise I, Sheet II.

CONSTRUCTION.—Draw AB $4\frac{1}{2}''$ long. Let P be the given point. With P as a center, and any radius, as PD , describe two short arcs cutting AB in the points C and D . With C and D as centers, and any convenient radius greater than PD , describe two arcs intersecting in E . Draw PE , and it will be perpendicular to AB at the point P .

CASE II.—*When the point is near the end of the line.*

See Exercise I, Sheet II.

CONSTRUCTION.—Draw AB $4\frac{1}{2}''$ long. Take the given point P about $\frac{3}{8}''$ from the end of the line. With any point O as a center, and a radius OP , describe an arc cutting AB in P and D . Draw DO , and prolong it until it intersects the arc in the point C . A line drawn through C and P will be perpendicular to AB at the point P .

PROBLEM 4.—To draw a perpendicular to a straight line from a point without it.

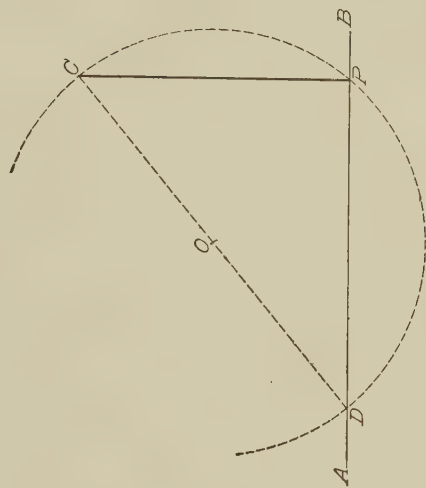
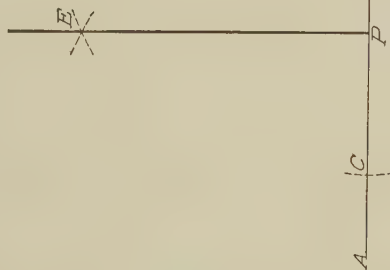
As in Problem 3, there are two cases.

CASE I.—*When the point lies nearly over the center of the line.*

See Exercise I, Sheet III.

CONSTRUCTION.—Draw AB $4\frac{1}{2}''$ long. Let P be the given point. With P as a center, and any radius PD greater than the distance from P to AB , describe an arc cutting AB in C and D . With C and D as centers, and any convenient

PROBLEM 3:
To draw a perpendicular to a straight line from a given point in that line.
Case I.



Case II.

radius, describe short arcs intersecting in E . A line drawn through P and E will be perpendicular to AB at F .

Case II.—*When the point lies nearly over one end of the line.*

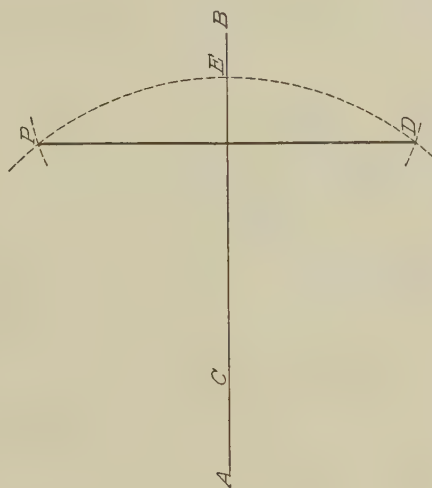
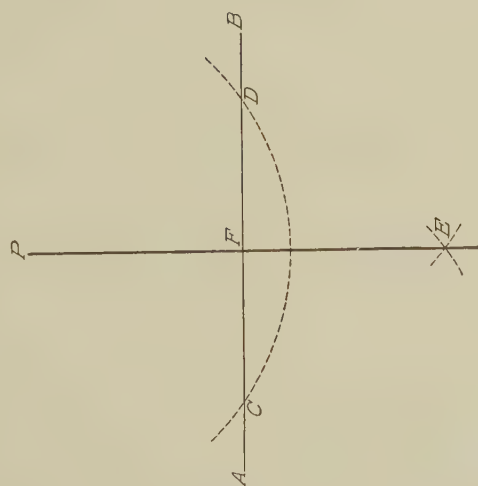
See Exercise I, Sheet III, Case II.

CONSTRUCTION.—Draw AB $4\frac{1}{2}''$ long, and let P be the given point. With any point C on the line AB as a center, and the distance CP as a radius, describe an arc PED cutting AB in E . With E as a center, and the distance EP as a radius, describe an arc cutting the arc PED in D . The line joining the points P and D will be perpendicular to AB .

These four problems form Exercise I. They are to be carefully and accurately drawn in with lead-pencil lines and then inked in. It will be noticed that in Exercise I, the given lines are *light*, the required lines *heavy*, and the construction lines, which in a practical working drawing would be left out, are *light dotted*. This system must also be followed in the four exercises that are to follow. A single glance enables one to see at once the reason for drawing the figure, and the eye is directed immediately to the required line.

In the first five exercises, accuracy and neatness are the main things to be looked out for. The student should be certain that the lines are of *precisely* the length that is specified in the description. When drawing a line through two points, be sure that the line goes through the points; if it does not pass exactly through the points, erase it and draw it over again. If a line is supposed to end at some particular point, make it end there—do not let it extend beyond or fall short. Thus, in Problem 2 if the line PC does not pass through the points P and C , it is not parallel to AB . By paying careful attention to these points, the student saves himself a great deal of trouble in the future. *Do not hurry your work.* If the student desires to submit his drawing for criticism before inking it in, he may do so; or he may complete the exercise entirely finished in ink if he prefer. When the pencil drawing is sent to us, we criticize the work and send it to the student to be inked and returned to us for a second

PROBLEM 4:
To draw a perpendicular to a straight line from a point without it.
Case I.



criticism when he sends his next exercise. To ink the drawing, proceed as follows:

First ink in all of the light lines and light dotted lines (which have the same thickness); then ink in the heavy required lines after the pen has been readjusted. Now do the lettering (read again carefully Arts. 24 to 35 under the head "Lettering"), and finally draw the heavy border lines, which should be thicker than any other line on the drawing.

Since Exercise I requires three sheets, the student will letter each of them as follows: After carefully lettering the subject of each problem in its proper place, draw in each of the upper corners $\frac{1}{8}$ " above the border line of each sheet two parallel lines as described in Art. 25. Between these lines, carefully letter the exercise number in the left corner and the sheet number in the right corner, as shown in the illustration on page 33. Then draw two similar parallel lines entirely across the bottom of the sheet $\frac{1}{8}$ " below the lower border line, and between these letter your name, class letters and number in the right corner, the date of completing the exercise in the left corner, and the entire time occupied in studying and drawing the problems on the sheet in the middle.

The object in putting the time occupied is to enable us to determine whether you have spent too much or too little time on the work as compared with the average student.

The title "Geometrical Drawing" should then be carefully drawn in with instruments on each sheet in the middle of the space at the top, as shown in the illustration on page 33, and according to the instructions given in Art. 34. Clean the drawing by rubbing very gently with the eraser. Care must be exercised when doing this, or the inked lines will also be erased. It is best to use a so-called "sponge rubber" for this purpose, as it will not injure the inked lines. *If any part of a line has been erased or weakened, it must be redrawn.*

Then write with the lead pencil your name and address in full on the back of each sheet, after which place all the sheets of the exercise in the large envelope that was sent you, and send them to the Schools.

HINTS FOR EXERCISE I

39. *Do not forget to make a distinction between the weight of the given and required lines, nor forget to make the construction lines dotted.*

When drawing dotted lines, take pains to have the dots and spaces uniform in length. Make the dots about $\frac{1}{16}$ " long and the spaces only about one-third the length of the dots.

Try to get the work accurate. The constructions must be accurate, and all lines or figures should be drawn of the length or size previously stated. To this end, work carefully and keep the pencil leads very sharp, so that the lines will be fine.

The lettering on the first few plates, as well as on the succeeding plates, is fully as important as the drawing, and should be done in the neatest possible manner. Drawings sent in for correction with the lettering omitted will be returned for completion.

Do not neglect to trim the plates to the required size. Do not punch large holes in the paper with the dividers or compasses.

Be sure to have your class letters and number distinctly marked on each sheet of each exercise.

EXERCISE II

40. This exercise, as the previous one, will consist of three sheets of two figures each.

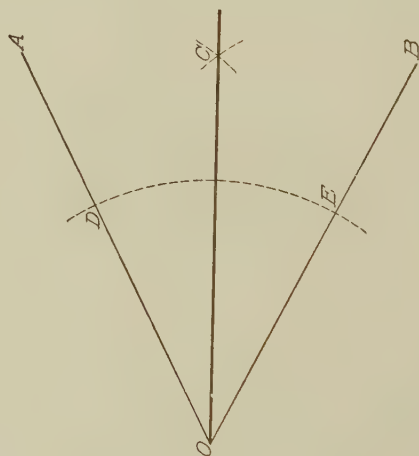
PROBLEM 5.—To bisect a given angle.

Case I.—*When the sides intersect within the limits of the drawing.*

See Exercise II, Sheet I.

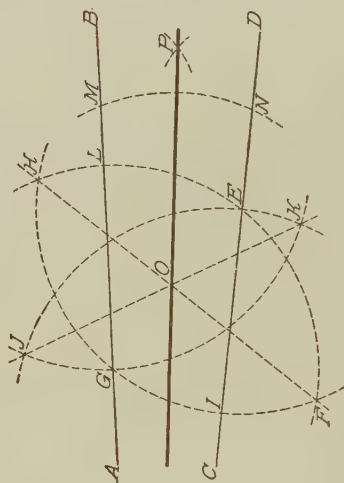
CONSTRUCTION.—Let AOB be the angle to be bisected. Draw the sides OA and OB $4\frac{1}{2}$ " long. With the vertex O as a center, and any convenient radius, describe an arc DE intersecting OA at D and OB at E . With D and E as centers, and a radius greater than the chord of half the arc DE , describe two arcs intersecting at C . The line drawn through C and O will bisect the angle; that is, $AOB = COB$.

To bisect a given angle.
Case I.



PROBLEM 5

To bisect a given angle.
Case II.



Case II.—*When the sides do not intersect within the limits of the drawing.*

See Exercise II, Sheet I.

CONSTRUCTION.—Draw two lines, AB and CD , each $4\frac{1}{2}''$ long, and incline toward each other as shown. With any point E on CD as a center and any convenient radius, describe arc $FIGH$; with G as a center and same radius, describe arc $HLEF$, intersecting $FIGH$ in H and F . With L as a center and same radius, describe arc KGJ ; with I as a center and same radius, describe arc JEK , intersecting KGJ in K and J . Draw HF and JK ; they intersect at O , a point on the bisecting line. With O as a center and the same or any convenient radius, describe an arc intersecting AB and CD in M and N . With M and N as centers and any radius greater than one-half MN , describe arcs intersecting at P . A line drawn through O and P is the required bisecting line.

PROBLEM 6.—**To divide a given straight line into any required number of equal parts.**

See Exercise II, Sheet II.

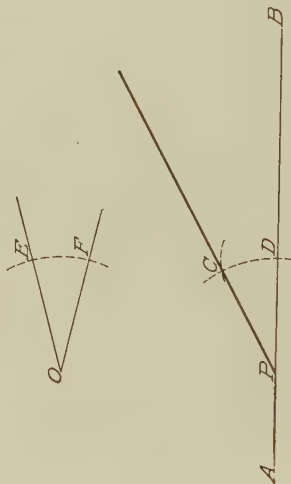
CONSTRUCTION.— AB is the given line $4\frac{1}{2}''$ long. It is required to divide it into eight equal parts. Through one extremity A of the line, draw an indefinite straight line AC , making any angle with AB . Set the dividers to any convenient distance, and space off eight equal divisions on AC , as AK, KI, IH , etc. Join C and B by the straight line CB , and through the points D, E, F, G , etc. draw lines DL, EM , etc. parallel to CB , by using the two triangles; these parallels intersect AB in the points L, M, N , etc., which are equally distant apart. The spaces LM, MN, NO , etc. are each equal to one-eighth AB . Proceed in a similar way for any number of equal parts into which AB is to be divided.

Another method is shown in Fig. 45. Draw AB as before, and erect the perpendicular BC . Now divide the length of AB by the number denoting the number of equal parts into which AB is to be divided, obtaining, in this case,

PROBLEM 6: To divide a given straight line into any required number of equal parts.



PROBLEM 7: To draw a straight line through any given point on a given straight line to make any required angle with that line.



$3\frac{7}{16}'' \div 8 = \frac{5\frac{5}{8}}{128}''$. As AC is longer than AB , the equal divisions AK, KI , etc. are longer than AT, TR , etc. and may be made any convenient length greater than $AB \div 8$. In this case, $\frac{1}{2}''$ is the most convenient fraction nearest to and greater than $\frac{5\frac{5}{8}}{128}''$; hence, consider AK, KI , etc. to be each $\frac{1}{2}''$ in length, thus making the length of AC $8 \times \frac{1}{2}'' = 4''$. With A as a center and a radius equal to $4''$, describe an arc cutting BC in C , and draw AC . Then with a scale lay off $AK = KI = \text{etc.} = \frac{1}{2}''$, and project K, I, H , etc. on AB , in T, R, P , etc., the required points. The advantage of this method over the other is that the T square and triangle can be used throughout, thus making it very much easier to draw the parallels DL, EM , etc.

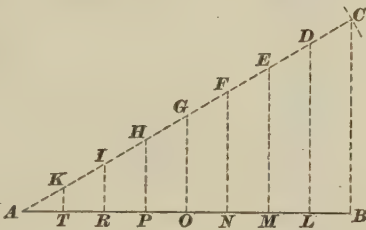


FIG. 45

The student, when drawing this exercise, is at liberty to use either of the methods given in this problem.

PROBLEM 7.—To draw a straight line through any given point on a given straight line to make any required angle with that line.

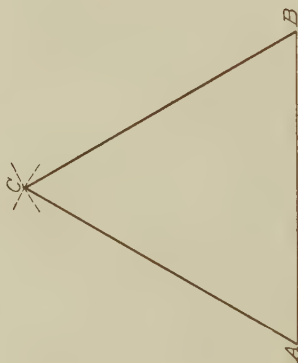
See Exercise II, Sheet II.

CONSTRUCTION.— AB is the given line $4\frac{1}{2}''$ long, P is the given point, and EOF is the given angle. With the vertex O as a center, and any convenient radius, describe an arc EF cutting OE and OF in E and F . With P as a center, and the same radius, describe an arc CD . With D as a center, and a radius equal to the chord of the arc EF , describe an arc cutting CD in C . A line drawn through the points P and C will make an angle with AB equal to the angle O , or $CPD = EOF$.

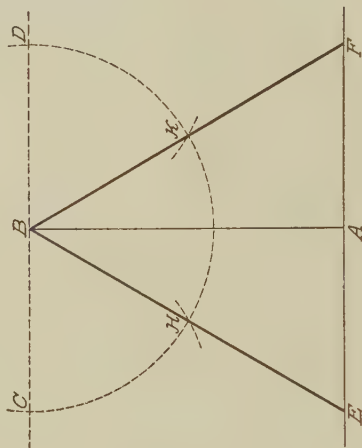
PROBLEM 8.—To draw an equilateral triangle, one side being given.

See Exercise II, Sheet III.

PROBLEM 8: To draw an equilateral triangle, one side being given.



PROBLEM 9: The altitude of an equilateral triangle being given, to draw the triangle.



CONSTRUCTION.— AB is the given side $3\frac{1}{4}"$ long. With AB as a radius, and A and B as centers, describe two arcs intersecting in C . Draw CA and CB , and CAB is an equilateral triangle.

PROBLEM 9.—The altitude of an equilateral triangle being given, to draw the triangle.

See Exercise II, Sheet III.

CONSTRUCTION.— AB is the altitude $3\frac{1}{4}"$ long. Through the extremities of AB draw the parallel lines CD and EF perpendicular to AB . With B as a center, and any convenient radius, describe the semicircle $CHKD$ intersecting CD in C and D . With C and D as centers, and the same radius, describe arcs cutting the semicircle in H and K . Draw BH and BK , and prolong them to meet EF in E and F . BEF is the required equilateral triangle.

This problem finishes Exercise II. The directions for inking in, lettering, etc. are the same as for Exercise I. In the upper corners of each sheet above the border line, letter the exercise number and sheet number, and in the lower corners and center below the border line letter the name, date, time, etc. as before. The title Geometrical Drawing should be placed on each Sheet. The three sheets of Exercise II should then be placed in the envelope and mailed to the Schools.

EXERCISE III

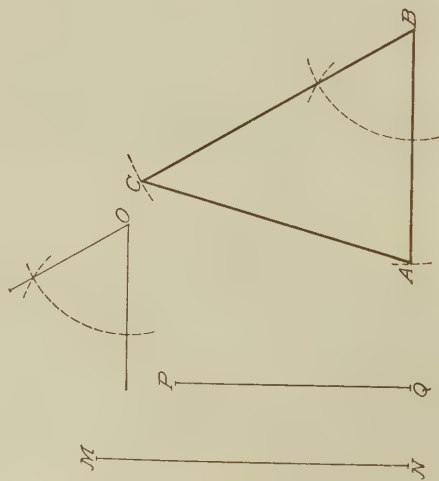
41. This exercise is to be arranged on three sheets like Exercises I and II, and the six following problems are to be drawn in a similar manner:

PROBLEM 10.—Two sides and the included angle of a triangle being given, to construct the triangle.

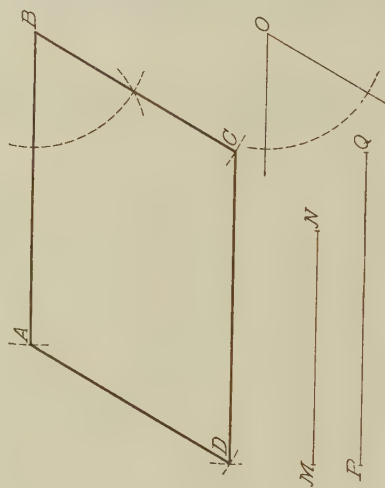
See Exercise III, Sheet I.

CONSTRUCTION.—Make the given sides MN $3\frac{1}{4}"$ long and PQ $2\frac{1}{2}"$ long. Let O be the given angle. Draw AB , and make it equal in length to PQ . Make the angle CBA

PROBLEM 10: Two sides and the included angle of a triangle being given, to construct the triangle.



PROBLEM 11: To draw a parallelogram when the sides and one of the angles are given.



equal to the given angle O , and make CB equal in length to the line MN . Draw CA , and CAB is the required triangle.

PROBLEM 11.—To draw a parallelogram when the sides and one of the angles are given.

See Exercise III, Sheet I.

CONSTRUCTION.—Make the given sides MN $2\frac{1}{2}''$ long and PQ $3\frac{1}{4}''$ long. Let O be the given angle. Draw AB equal to PQ , and draw BC , making an angle with AB equal to the given angle O . Make BC equal to MN . With C as a center, and radius equal to PQ , describe an arc at D . With A as a center, and a radius equal to MN , describe an arc intersecting the other arc in D . Draw AD and CD , and $ABCD$ is the required parallelogram.

PROBLEM 12.—An arc and its radius being given, to find the center.

See Exercise III, Sheet II.

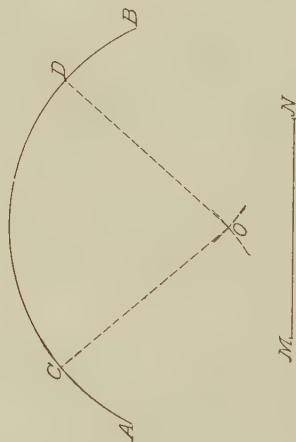
CONSTRUCTION.— $ACBD$ is the arc, and MN , $2\frac{1}{4}''$ long, is the radius. With MN as a radius, and any point C in the given arc as a center, describe an arc at O . With any other point D in the given arc as a center, and the same radius, describe an arc intersecting the first in O . O is the required center.

PROBLEM 13.—To pass a circumference through any three points not in the same straight line.

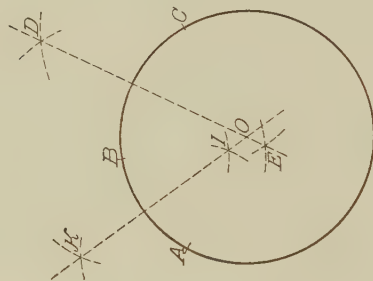
See Exercise III, Sheet II.

CONSTRUCTION.— A , B , and C are the given points. With A and B as centers, and any convenient radius, describe arcs intersecting each other in K and I . With B and C as centers, and any convenient radius, describe arcs intersecting each other in D and E . Through I and K and through D and E , draw lines intersecting at O . With O as a center, and OA as a radius, describe a circle; it will pass through A , B , and C .

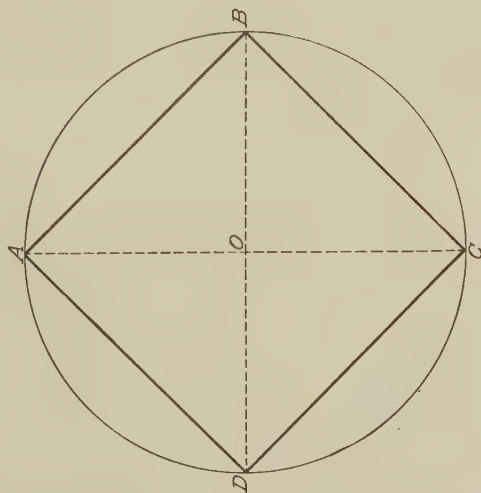
PROBLEM 12: An arc and its radius being given, to find the center.



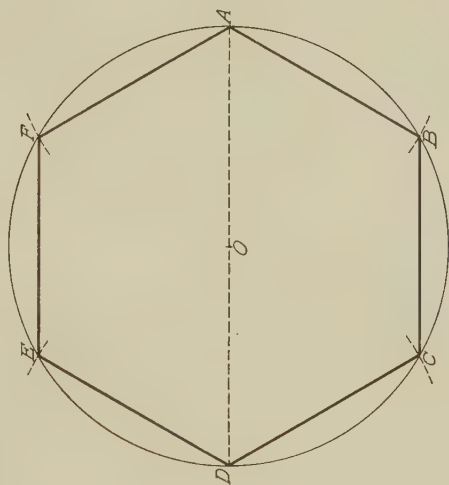
PROBLEM 13: To pass a circumference through any three points not in the same straight line.



PROBLEM 14: To inscribe a square in a given circle.



PROBLEM 15: To inscribe a regular hexagon in a given circle.



PROBLEM 14.—To inscribe a square in a given circle.

See Exercise III, Sheet III.

CONSTRUCTION.—The circle $ABCD$ is $4\frac{1}{2}''$ in diameter. Draw two diameters, AC and DB , at right angles to each other. Draw the lines AB , BC , CD , and DA , joining the points of intersection of these diameters with the circumference of the circle, and they will be the sides of the square.

PROBLEM 15.—To inscribe a regular hexagon in a given circle.

See Exercise III, Sheet III.

CONSTRUCTION.—From O as a center, with the compasses set to $2\frac{1}{4}''$, describe the circle $ABCDEF$. Draw the diameter DOA , and from the points D and A , with the compasses set equal to the radius of the circle, describe arcs intersecting the circle at E , C , F , and B . Join these points by straight lines, and they will form the sides of the hexagon. This problem completes Exercise III. The lettering of the exercise number, sheet number, name, class letters and number, etc., is to be completed above the upper and below the lower border lines as before; and the sheets mailed, in the large envelope, to the Schools.

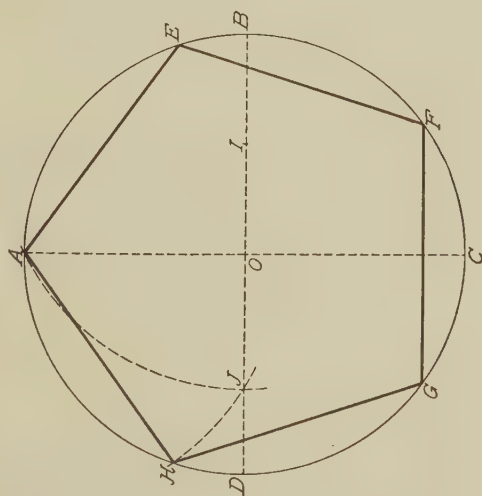
EXERCISE IV

42. The first four problems of this exercise are more difficult than any of the preceding problems and will require very careful construction. All the sides of each polygon must be of exactly the same length, so that they will space around evenly with the dividers. The figures should not be inked in, but the pencil construction must be done very accurately. The preliminary directions for this plate are the same as for the preceding ones.

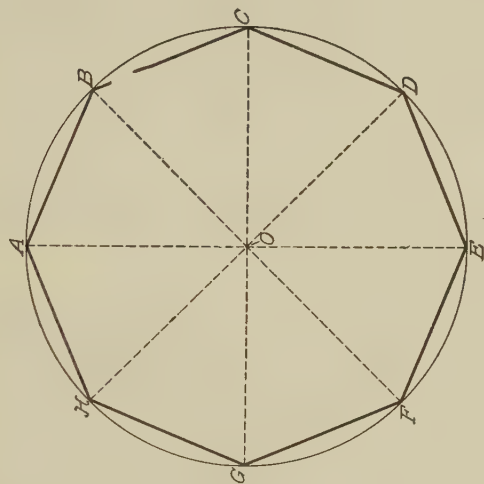
PROBLEM 16.—To inscribe a regular pentagon in a given circle.

See Exercise IV, Sheet I.

PROBLEM 16: To inscribe a regular pentagon in a given circle.



PROBLEM 17: To inscribe a regular octagon in a given circle.



CONSTRUCTION.—From O as a center, with the compasses set to $2\frac{1}{4}''$, describe the circle $ABCD$. Draw the two diameters AC and DB at right angles to each other. Bisect one of the radii, as OB , at I . With I as a center, and IA as a radius, describe the arc AJ cutting DO at J . With A as a center, and AJ as a radius, describe an arc JH cutting the circumference at H . The chord AH is one side of the pentagon.

PROBLEM 17.—To inscribe a regular octagon in a given circle.

See Exercise IV, Sheet I.

CONSTRUCTION.—From O as a center, with the compasses set to $2\frac{1}{4}''$, describe the circle $ABCDEFGH$. Draw the two diameters AE and GC at right angles to each other. Bisect one of the four equal arcs, as AG at H , and draw the diameter HOD . Bisect another of the equal arcs, as AC at B , and draw the diameter BOF . Straight lines drawn from A to B , from B to C , etc. will form the required octagon.

PROBLEM 18.—To construct a regular octagon within a given square.

See Exercise IV, Sheet II.

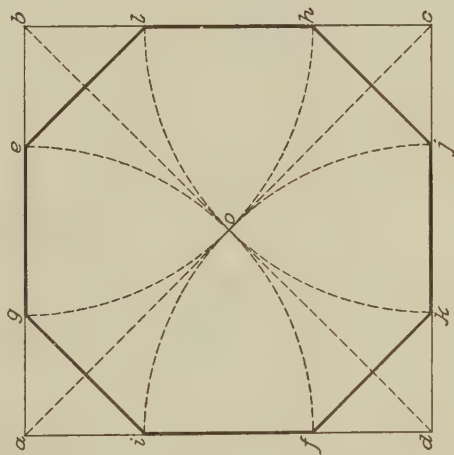
CONSTRUCTION.—Draw the square $abcd$ $4\frac{1}{4}''$ on each side. Draw the diagonals ac and bd intersecting at o . From a and d as centers, and with a radius ao equal to half of one diagonal, describe the arcs ef , gh , ij , and kl . Now draw the octagon from the points indicated.

PROBLEM 19.—To construct an ellipse without instruments.

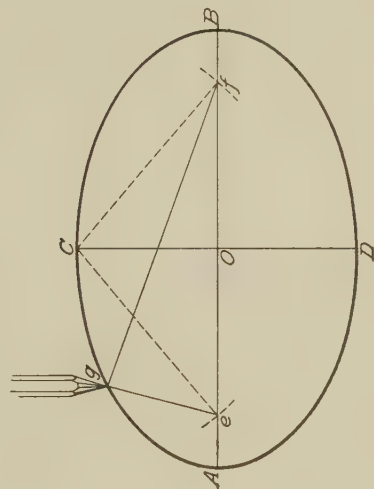
See Exercise IV, Sheet II.

CONSTRUCTION.—Let AB and CD be the longitudinal and transverse axes of the ellipse $4\frac{1}{2}''$ and $3''$ long, respectively. From C lay off ce and cf equal to AO . Through e and f drive two needles, or small pins. Tie a piece of thread between these two pins, of such a length that it will reach also to C as shown by the dotted line eCf .

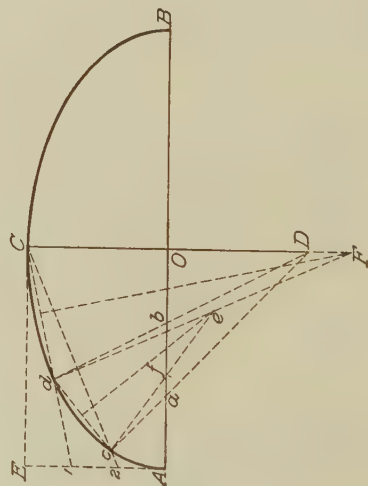
PROBLEM 18: To construct a regular octagon within a given square.



PROBLEM 19: To construct an ellipse without instruments.



PROBLEM 20: To construct an ellipse approximately by means of circular arcs.



PROBLEM 21: To describe the arc of a circle too large for the dividers.



Now, by inserting the point of a pencil under this thread and moving it from A to B , at the same time keeping the thread taut, one-half of the required ellipse will be described. The other half may be similarly described on the opposite side of the longitudinal axis.

PROBLEM 20.—To construct an ellipse approximately by means of circular arcs.

See Exercise IV, Sheet III.

CONSTRUCTION.—Lay off AB , $4\frac{1}{2}''$ as the longitudinal axis of the ellipse and CD $3''$ as the transverse axis. Draw AE parallel and equal to OC and divide it into three equal parts as shown at 1 and 2. Divide AO into three equal parts as at a and b . Draw $C1$ and $C2$, and from D through a and b draw Dc and Dd cutting the lines $C1$ and $C2$ at c and d . Bisect Cd by a perpendicular line prolonged until it meets CD at F , and draw Fd . Draw cd and bisect it with a perpendicular intersecting Fd at e . Draw ec cutting AO at f . Then with F as a center draw the arc Cd , and with e as a center draw dc and with f as a center draw cA . The opposite side may be drawn in a similar manner. This method of drawing an ellipse is sometimes used in laying out an arch in a brick or stone wall as the joints in the masonry can be easily made to radiate from definite centers.

PROBLEM 21.—To describe the arc of a circle too large for the dividers.

See Exercise IV, Sheet III.

CONSTRUCTION.—Draw AB $4\frac{1}{2}''$ equal to the chord of the required arc, and OC $\frac{1}{2}''$ equal to the height of the arc above the center of the chord. Now, on a separate piece of paper $acbef$ draw the diagram shown in Fig. 46, making

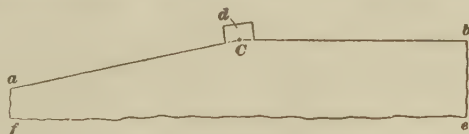


FIG. 46

the angle aCb equal to the angle ACb in Problem 21. With a sharp knife or a pair of scissors cut off the top of the

paper on the lines aC and Cb , Fig. 46, leaving a small portion at d as shown. Now drive two needles or small pins through the points A and C , Problem 21, and perforate the point c in Fig. 46 and place the piece of paper $aCbef$ over the drawing of Problem 21, so that the edges aC and Cb rest against the pins driven through A and C . Now with the point of the pencil through the hole C slide the paper along against the pins and the required arc from C to A will be described. The other half from C to B may be similarly drawn by transferring the pin from A to B and moving the paper to the other side. The lettering for the sheets of this exercise should now be placed at the five accustomed places as before, and the sheets mailed to the Schools.

CONIC SECTIONS

43. In Fig. 47 are shown two similar cones abc and ade , which are in contact with each other at their vertexes a ,

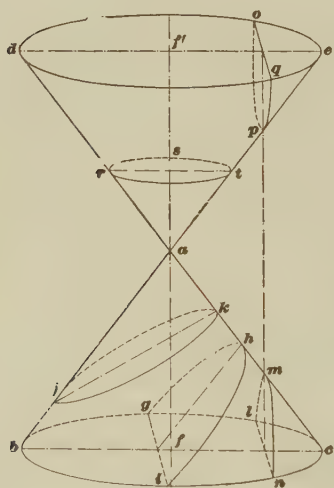


FIG. 47

and whose bases bc and de are circular and at right angles to the axes af and af' . If either of the cones be intersected or cut by a plane that is parallel to one of its elements or sides, as be , the line of intersection will be a *parabola*, as at ghi ; but, if, instead of being parallel to the side be , the cutting plane makes an angle with it, the curve formed by the intersection will be either an ellipse or a hyperbola, according to the angle. It will be an ellipse when the cutting plane is more nearly parallel with the base of

the cone than it was in the case of the parabola, and passes through both sides as at jk ; and the line of intersection will be a hyperbola when the cutting plane is more nearly

perpendicular to the base than it was in the case of the parabola, as shown at lmn and opq .

44. In the case of the hyperbola, the plane will always cut both cones, thereby giving two branches to the curve and these branches will be farther apart as the cutting plane recedes from the axes of the cones. The nearer the plane approaches the axes of the cones, the straighter will become the sides of the intersecting curve; and as the plane recedes from the axes, the rounder and nearer circular will be the intersection, though, no matter how closely the curve of intersection may approach the arc of a circle, it can never become absolutely circular in form.

The hyperbola becomes two intersecting straight lines when the plane passes through the vertex; these two lines are most divergent when the plane is parallel with the axes of the cones, and gradually become closer together as the plane approaches a position parallel with the side of the cone, where the hyperbola reaches its limit in a straight line. This straight line is the common limit of both hyperbola and parabola, as any deviation from it will produce one or the other of these curves, according to the direction of that deviation.

45. As the plane of the ellipse becomes more nearly parallel to the base of the cone, the ellipse approaches the form of a circle, which it finally becomes, when the axis of the cone and the cutting plane are perpendicular to each other, as at rst , and as the plane of the ellipse approaches the vertex of the cone the ellipse diminishes in size until it reaches its limit in a point. From a point to a circle, then, is the limit of curvature of the ellipse.

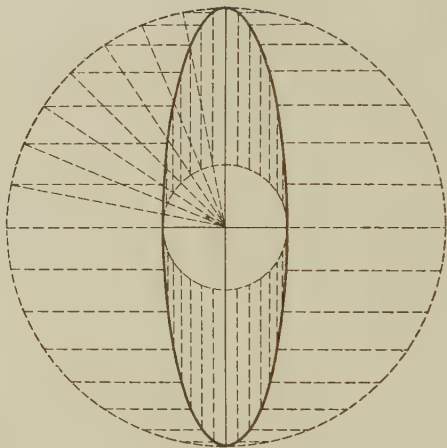
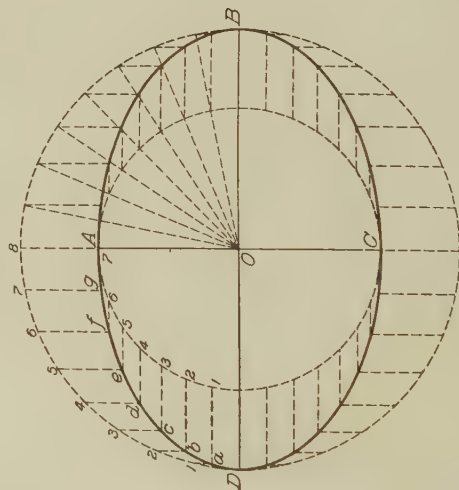
EXERCISE V

PROBLEM 22.—To draw an ellipse, the diameters being given.

See Exercise V, Sheet I.

Case I.—CONSTRUCTION.—Let BD , the long diameter, or major axis, $4\frac{1}{2}''$ in length, and AC , the short diameter, or

PROBLEM 22:
To draw an ellipse, the diameters being given.
Case I.



minor axis, 3" in length, intersect at right angles to each other in the center O , so that $DO = OB$ and $AO = OC$. With O as a center, and OC as a radius, describe a circle; with the same center, and OD as a radius, describe another circle. Divide both circles into the same number of equal parts, as 1-2, 2-3, etc. This is best done by first dividing the larger circle into the required number of parts, beginning at the center line AC , and then drawing radial lines through the points of division on this circle, to the center O of the circles, as shown in the upper right-hand quarter of the figure. The radial lines will divide the smaller circle into the same number of parts that the larger one has been divided into. Through the points of division on the smaller circle, draw horizontal lines, and, through the points of division on the larger circle, draw vertical lines; the points of intersection of these lines are points on the ellipse. Thus, the horizontal line $3c$ and the vertical line $3c$ intersecting at c give the point c of the ellipse. Trace a curve through the points thus found by placing an irregular curve on the drawing in such a manner that one of its bounding lines will pass through three or more points, judging with the eye whether the curve so traced bulges out too much or is too flat. Then adjust the curve again, so that its bounding line will pass through several more points, and so on, until the curve is completed. Care should be taken to make all changes in curvature as gradual as possible, and all curves drawn in this manner should be drawn in pencil before being inked in. It requires considerable practice to be able to draw a good curved line in this manner by means of an irregular curve, and the general appearance of a curve thus drawn depends a great deal on the student's taste and the accuracy of his eye.

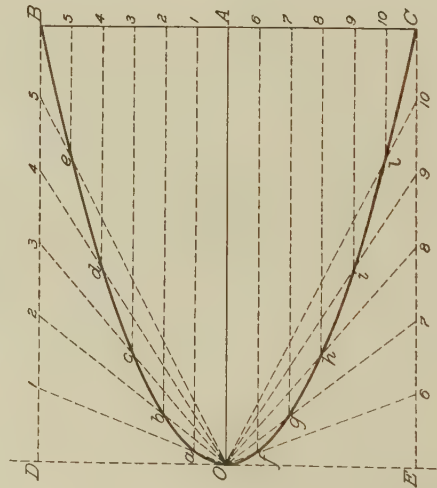
Case I.—Execute the same problems with a major axis of $4\frac{1}{2}$ " and a minor axis of $1\frac{3}{8}$ ".

PROBLEM 23.—To draw a parabola, the axis and longest double ordinate being given.

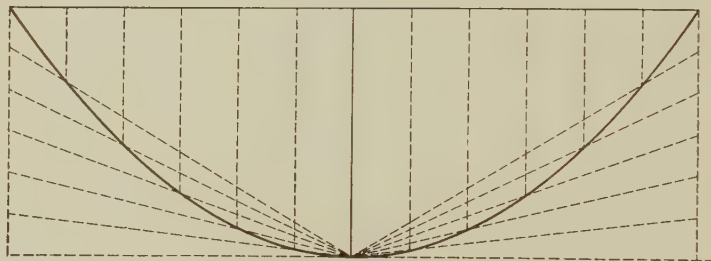
See Exercise V, Sheet II.

PROBLEM 23: To draw a parabola, the axis and longest double ordinates being given.

Case I.

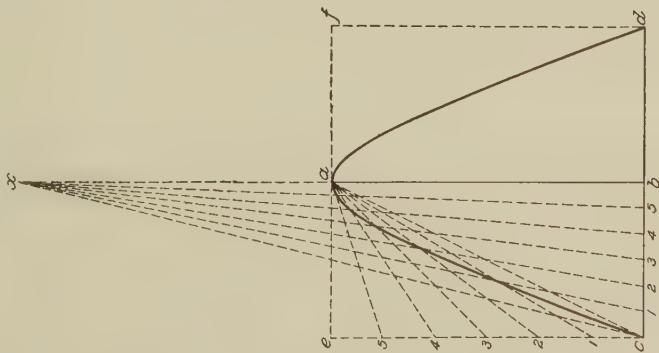


Case II.

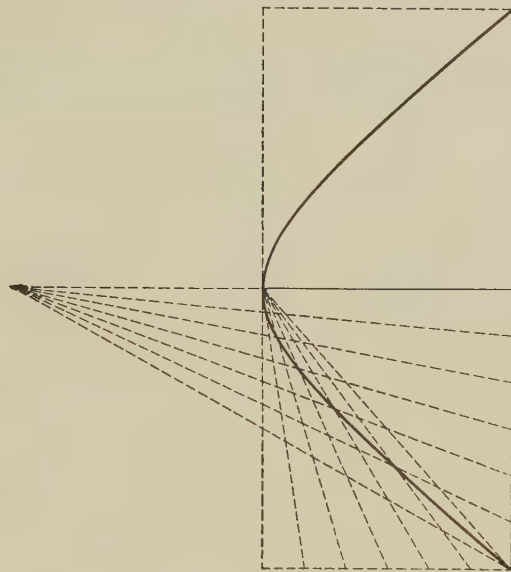


PROBLEM 24: To construct a hyperbola, the width and height being given.

Case I.



Case II.



Case I.—EXPLANATION.—The curve shown in problem 23 is a parabola. The axis OA , which bisects the area included between the curve and the line BC , is $4\frac{1}{2}''$ in length. Any line, BA or AC , drawn perpendicular to OA , and whose length is included between OA and the curve, is called an **ordinate**. Any line, as BC , both of whose extremities rest on the curve, and is perpendicular to the axis, is called a **double ordinate**. The point O is called the **vertex**.

CONSTRUCTION.—Lay off the axis OA its proper length, and the longest double ordinate $BC\ 4''$. BA , of course, equals AC . Draw DE through the other extremity of the axis and perpendicular to it; also draw BD and CE perpendicular to BC and intersecting DE in D and E . Divide DB and AB into the same number of equal parts, as shown (in this case six); through the vertex O , draw $O1, O2$, etc. to the points of division on DB , and through the corresponding points $1, 2$, etc. on AB , draw lines parallel to the axis. The points of intersection of these lines a, b, c , etc., are points on the curve, through which it may be traced. In a similar manner, draw the lower half $O f g h i l C$ of the curve.

Case II.—Execute this same problem with an axis of $2\frac{1}{2}''$ and a double ordinate of $7''$.

PROBLEM 24.—To draw a hyperbola, the width and height being given.

See Exercise V, Sheet III.

Case I.—EXPLANATION.—The axis $ab\ 3\frac{1}{4}''$, is laid down perpendicular to the width $cd\ 3\frac{1}{4}''$, in the same manner as for the parabola, and the rectangle $cdfe$ is constructed with ef equal to the base of the hyperbola, and the height ce equal to the axis ab . Divide one-half the base and also each side into any number of equal parts, and connect the points of division on the sides with the vertex a by means of the lines $a1, a2, a3$, etc. The points of division on the base are connected by lines to some point x about $7''$ above b the line of the axis ab extended; the points of intersection of these two series of lines will determine points on the hyperbolic

curve, taking the lines in the order as they recede from point c ; x can be at any distance above a , and the curved lines ac and ad will approach more nearly the curves of the parabola as the point x becomes more remote. On the other hand, the nearer the point x is to the vertex a , the more ac and ad will approximate to a straight line, and when points x and a coincide, the lines ac and ad will be straight lines.

Case II.—Execute this same problem within a rectangle whose base cd is $5\frac{1}{2}''$ and whose height ce is $2\frac{1}{2}''$.

PROJECTION DRAWING

PROJECTIONS

1. Introduction.—When an instrumental or geometrical drawing is made to represent a definite object in a definite position, it is termed a **projection drawing**, as the form

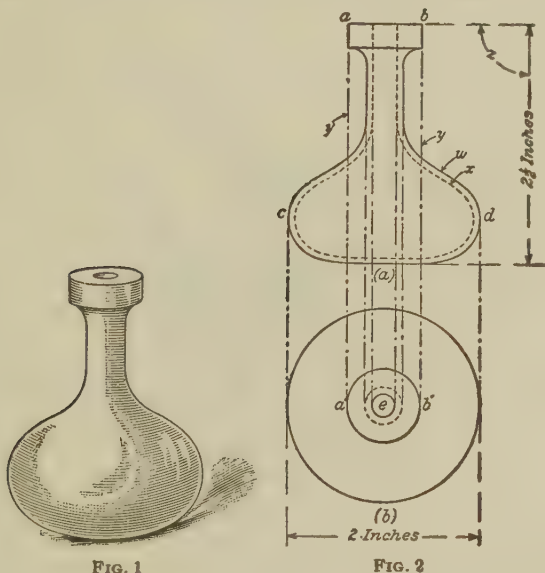


FIG. 1

FIG. 2

and dimensions of the object are projected on the paper in their actual proportions, thereby giving a diagram that can be scaled or measured so as to serve as a pattern.

In all branches of design wherein working drawings are required, projection drawing forms the basis of the operations where the resulting fabric is to be a solid article. In Fig. 1 is shown a perspective sketch of a small decanter,

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which conveys to the observer all its details of form and material, but does not give any exact dimension from which a similar article could be produced. In Fig. 2, however, is shown a projection drawing of the same decanter, (*a*) being the side view, usually called the **elevation**, while (*b*) is the top view, usually called the **plan**. The straight line representing the upper edge of the neck *ab* appears in plan as a circle, *a' b'*, and the full width of the decanter *cd* appears in plan as a larger circle; the hole through the neck of the decanter, which does not show at all in the elevation (except

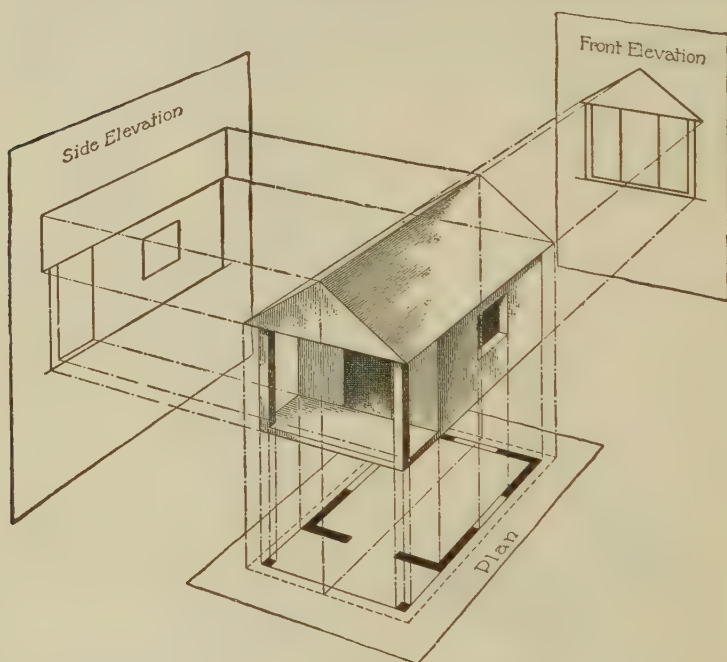


FIG. 3

by a dotted line that indicates the thickness of the glass), appears in the plan as the small circle *e*. This, then, is the simple principle of projection drawing, and whether the projected object be a line, a surface, or a solid, its entire form can be expressed in two or three drawings, showing the **views** of the top and of one or two sides.

In making projection drawings, it is assumed that the eye is always in front of each particular portion of the object, no matter how large it may be, and that the form projected in the plan is derived from outlines obtained by projecting each important point of the object to the drawing paper or to a plane, held in a vertical or horizontal position, according to whether we are making the elevation or the plan. In Fig. 3 is shown the application of this principle for a small building where the front elevation, side elevation, and plan are shown on three sheets to which they have been projected by imaginary lines drawn from the several parts of the building.

2. In making projection drawings, four general kinds of line are used.

The **full line** is used for indicating outlines of a figure and the parts that can be readily seen in their indicated positions, as *w*, Fig. 2.

The **dotted line**, consisting of a series of dashes about $\frac{1}{16}$ inch long, is used to indicate the position and shape of some part of the object that exists in the view projected, but is hidden by something being in front of it, as *x*, Fig. 2, where a dotted line is used to indicate the interior line of the decanter.

The **broken and dotted line**, consisting of a long dash and a dot or short dash repeated regularly, is used to indicate the center line of figures or parts of a figure, to show a line on which a section or cut has been taken, or to project the details of a part from one view to another, as *y*, Fig. 2, where the width of the top *ab* is projected into the plan at *a' b'* by means of broken and dotted lines *aa'* and *bb'*.

The **broken line**, consisting of a series of long dashes, is used almost exclusively for indicating the points between which the dimensions are taken, as at *z*, Fig. 2.

A specific use of any one of these lines for any particular purpose is not fixed by any rule, and different individuals adopt for themselves whichever arrangement best suits their fancy, but the above system will be followed in this Section and the student is to govern himself accordingly.

In general practice, the draftsman does not make any distinction between different forms of lines in his pencil drawing, but gives the distinguishing characteristics when he inks or traces his drawing.

EXERCISE I

3. Exercise I consists of four sheets containing four simple surfaces and eight solids. Each figure represents a plan and elevation. The sheets on which this and all subsequent exercises in this Section should be executed are to be $9'' \times 12''$, outside measurement. A border line is to be drawn a distance of $\frac{1}{2}''$ from the outside edges, except at the top where the width of the border should be $\frac{3}{4}''$ in order to allow for the printing of the title. Sheets I and III should have their long dimension vertical, while Sheets II and IV have their long dimension horizontal; and all four sheets should have a line in pencil through the center parallel with the longer sides. Sheets I and III also have horizontal pencil lines dividing them $7''$ above the lower border and vertical lines $2''$ each side of the center; the last to form the center lines for the figures drawn.

PROBLEM 1. Exercise I, Sheet I.—Draw Fig. 1, which is a disk, showing its plan as a circle cd and its elevation, a straight line ab . The center of the horizontal projection is $1\frac{1}{2}''$ above the horizontal dividing line and on the vertical center line of the upper left-hand rectangle; and the radius is $1\frac{1}{4}''$. The vertical projection, or elevation, of this disk can be drawn at any convenient point above it, say $\frac{1}{4}''$, its length being limited by the projection lines drawn tangent to each side of the circle. Fig. 1 then shows by its plan and elevation that it represents a disk whose thickness is equal to that of a single line.

PROBLEM 2.—Draw Fig. 2, whose plan is precisely the same as Fig. 1, with the center of the plan $1\frac{1}{2}''$ above the lower border line and on the vertical center line of the rectangle. The elevation of Fig. 2, however, appears as a rectangle $3\frac{1}{4}''$ high with its base $\frac{1}{4}''$ above the top of the plan, thus showing that, although the plan is the same as Fig. 1,

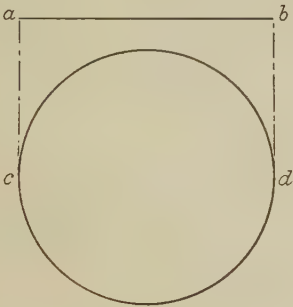


Fig. 1

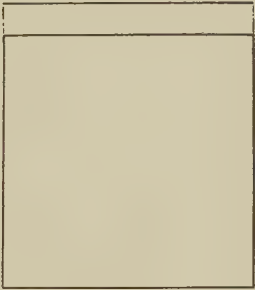


Fig. 3



Fig. 2



Fig. 4

the thickness or height is $3\frac{1}{4}''$; therefore, it represents a cylinder instead of a disk.

PROBLEM 3.—Draw the elevation as a straight line $2\frac{1}{2}''$ in length, the same as the elevation of Fig. 1 and on a line with it; i. e., about $\frac{3}{4}''$ below the upper border line. The plan, however, is a square $2\frac{1}{2}''$ on each side, showing that this figure is a square surface, such as a piece of tin, metal, paper, card, etc.

PROBLEM 4.—Fig. 4 is a plan identical with the plan of Problem 3, but the elevation, being a rectangle similar to the elevation of Fig. 2, shows that this object has a thickness of $3\frac{1}{4}''$, and is therefore a square prism.

Figs. 1 and 2 have the same plan, but the elevations show that they have a different thickness, and therefore while one is a disk the other is a cylinder. In Figs. 3 and 4, the elevation shows that one is a square surface and the other a square prism. Figs. 1 and 3, and 2 and 4 have the same elevations, but the plans show them to be different; thus, each is identified by a combination of its two projections.

PROBLEM 5. Exercise I, Sheet II.—To draw Figs. 5 and 6, divide the sheet through its longer dimension by a vertical center line, thus making two rectangles $7\frac{3}{4}'' \times 5\frac{1}{2}''$ inside the border lines. Draw vertical center lines through these smaller rectangles. The plan of Fig. 5 is the same as that of Figs. 1 and 2, a circle with a radius of $1\frac{1}{4}''$. This circle has its center about $2\frac{1}{4}''$ above the lower border line. The elevation of Fig. 5, however, appears as a triangle, thereby indicating that the solid is a cone. The height of this triangle is the same as the cylinder of Fig. 2, namely, $3\frac{1}{4}''$ and has its base $4''$ above the lower border line.

PROBLEM 6.—Fig. 6 has for the elevation a triangle, also identical with that of Fig. 5 (and in drawing it place the base on a level with that in Fig. 5), but the plan, being square, shows that Fig. 6 represents a square pyramid.

4. In these six simple problems are illustrated the general principles of projection drawing; and in every ordinary instance a combination of two drawings showing the plan

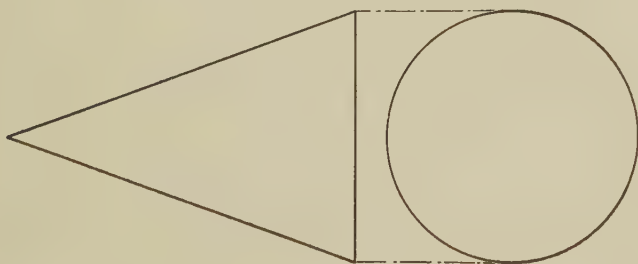


Fig. 5

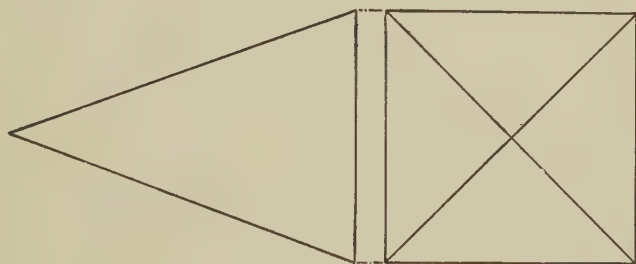


Fig. 6

and one elevation will convey a general idea of the outlines of any regular solid. In Problems 7 to 12, no new principle is introduced, as Problems 7 and 8 are drawings of polygonal surfaces; Problems 9 and 10, polygonal prisms; and Problems 11 and 12, polygonal pyramids.

PROBLEMS 7 TO 12. Exercise 1, Sheets III and IV.—The figures are to be arranged on the drawing paper in the same manner as were the figures on Sheets I and II. The figures are to be drawn according to the dimensions given for the problems on Sheets I and II, except the plans of Figs. 8, 10, and 12, which are to be made $2\frac{5}{16}''$ between parallel sides. The octagons in the plan of these figures can be readily constructed according to Problem 18, *Geometrical Drawing*. Draw these figures in the exercise as directed, but observe that in the elevation the angles or corners that appear at *a* and *b* in Fig. 9 are shown in the elevation as vertical lines extending through the surface. In Fig. 11, these lines in extending through the surface from the corners *a* and *b* converge to the apex of the pyramid, thus indicating the character of the solid.

The four sheets having been completed in pencil, they must next be inked in. All the full lines should be of the same thickness, all corners and intersections sharp, and the lettering done with great care.

Letter the title PROJECTIONS, and the exercise number and sheet number at the top of each sheet. Also insert the name, class letters, and number, date, and time consumed, etc. at the bottom in their proper places, as heretofore.

The time consumed should be the actual time used in making the drawing. The beginner is urged to take sufficient time in drawing all sheets, and aim to do them well rather than quickly.

The sheets should be cleaned with a soft rubber, and mailed to the Schools for correction.

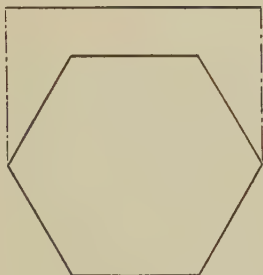


Fig. 7

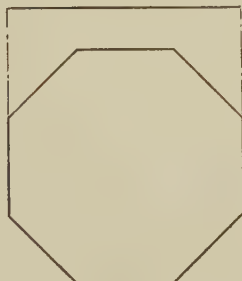


Fig. 8

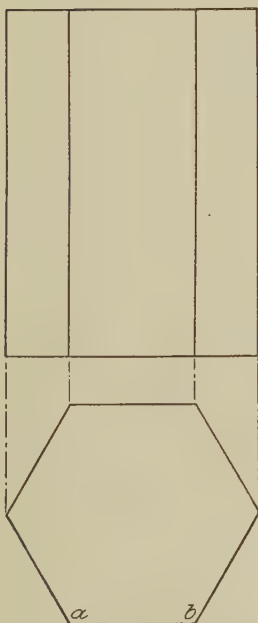


Fig. 9

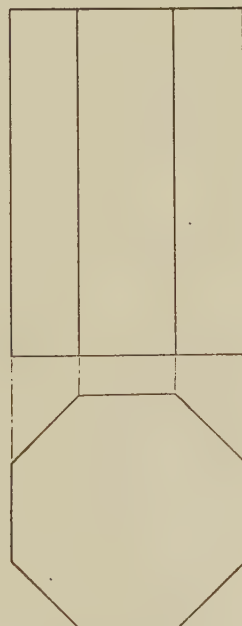


Fig. 10

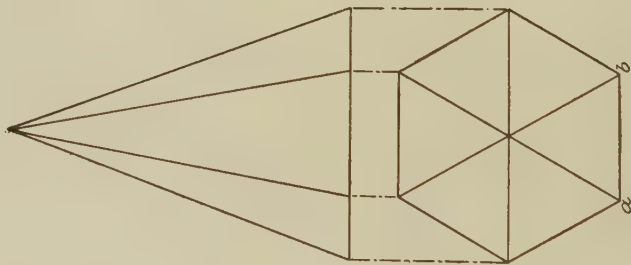


Fig. 11

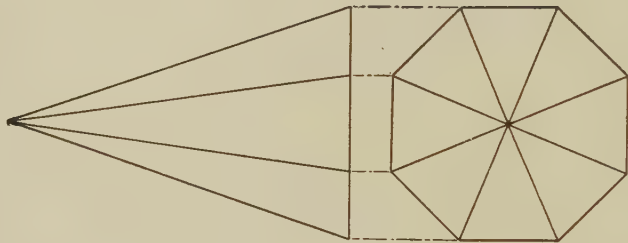


Fig. 12

EXERCISE II

5. Exercise II consists of six sheets, each presenting three views of a geometrical solid. Two of these views must be drawn according to instructions in order to find the third one. Each sheet, as before, will be $9'' \times 12''$ with a working space of $7\frac{3}{4}'' \times 11''$ inside the border line, and all sheets will be placed horizontally. The line AB through the center of the sheet will mark the division between the vertical and horizontal projections, and the elevations should be arranged to rest on this line.

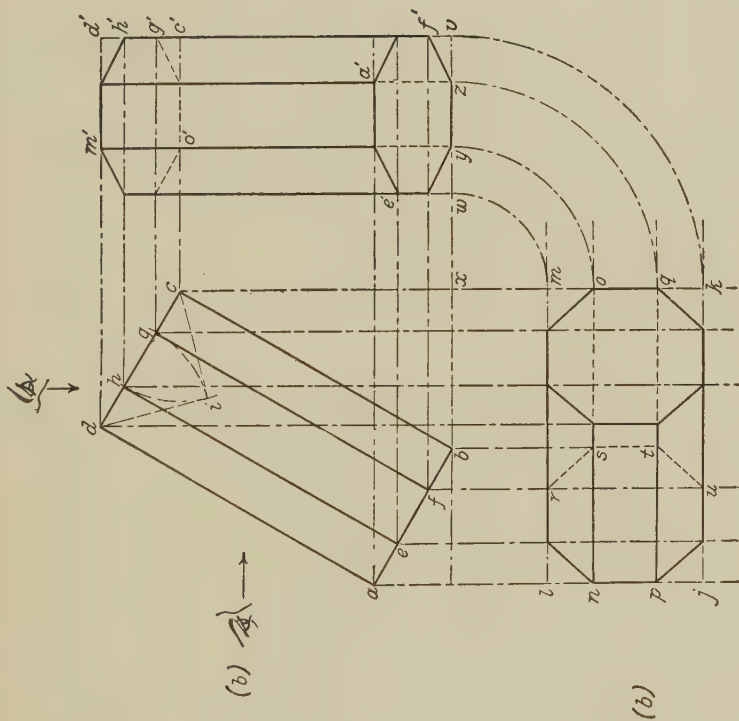
PROBLEM 13. Exercise II, Sheet I.—The figure on Sheet I, Exercise II, is a rectangular prism $1\frac{5}{8}''$ square on the base and $3\frac{1}{4}''$ high. First draw the plan (a) locating the point a about $1\frac{1}{4}''$ above the lower border line, and $4''$ to the right of the side border line. ab , $1\frac{5}{8}''$ long, is then drawn at an angle of 30° with the horizontal as shown. With the 30° and 60° triangle, the plan of the prism $abcd$ should then be drawn, and lines from its corners projected into the vertical plane, as shown at kh , me , lf , etc. The height $3\frac{1}{4}''$ is then laid off from k to h , and the line hf drawn as shown.

The views of the prism are taken in the directions of the arrows shown, and therefore, in the elevation, the entire thickness of the prism is between the eye and the corner c , viewed as indicated in the plan by the arrow (a). Hence, the corner c is hidden and shown by a dotted line ng in the elevation. The other elevation of the prism $orst$ is a view taken in the direction of the arrows (b) at the side of the elevation and the plan. To draw this, the points d , c , a , and b should be projected horizontally to the line pl , or any other vertical line conveniently located. Then where this line intersects with the line kt (which in this case happens to be at l), a center is taken and arcs are drawn as from c' to o , d' to q , b to u , and p to t . Vertical lines drawn through the points o , q , u , and t , and horizontal lines drawn on a level with the top and bottom of

the prism in the previous elevation, limit the form of this figure. The view being taken from the side of the plan as shown by the arrow, the point d is in full view and is shown by the vertical line qw in the side elevation, whereas the point b is on the back or further side of the prism and is therefore invisible and appears in the side elevation as a dotted line ux . The peculiarity of this problem is that the front elevation and side elevation are precisely alike; as a matter of fact, the side elevation is unnecessary, because one can determine from the plan exactly what the form and proportions of the figure are.

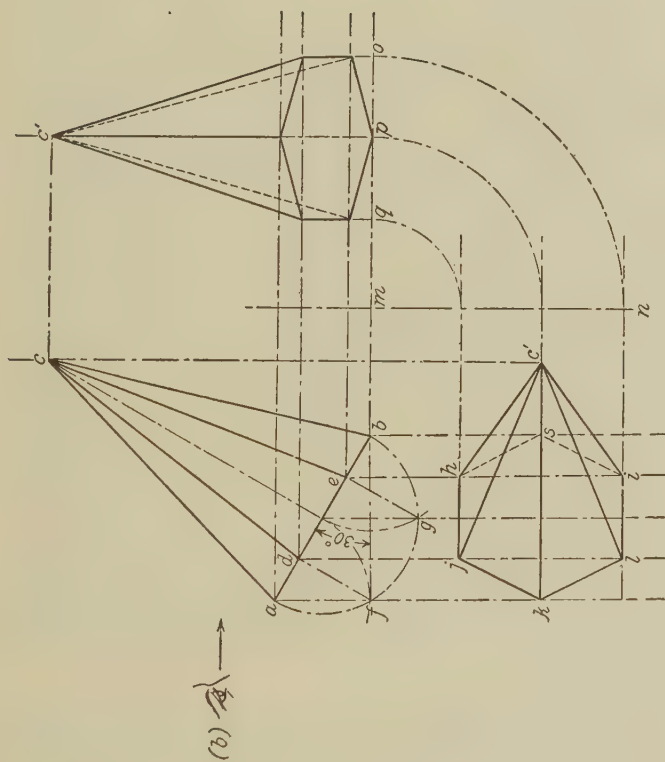
6. PROBLEM 14. Exercise II, Sheet II.—A different state of affairs exists in Problem 14, however, which is another view of this same prism in which the elevation is inclined, and the plan is parallel with the horizontal line AB through the center of the plate. The problem here is to find the side elevation. Draw the front elevation $abcd$ with its lower corner b resting on the horizontal center line, and $1\frac{5}{8}''$ to the left of the vertical center line. The sides da and cb are inclined at an angle of 60° with AB , and the whole elevation is equal in dimension to the width and height of the prism on Sheet I, Exercise II; that is, the width ab , Sheet I, is the same as ab , Sheet II; and the height kh , Sheet I, is equal to ad , Sheet II. The side ef of the plan is then laid out to its proper dimension, $1\frac{5}{8}''$ long, f being immediately under a of the elevation, and $1\frac{1}{2}''$ above the lower border line. Horizontal lines fg and eh are drawn from ef indefinitely to the right. A perpendicular line from the corner c intersects these horizontal lines at h and g and limits the length of the prism in plan to eh , while a perpendicular line drawn from d shows the amount of surface at the top that can be seen by looking down at the prism and determines the size of the rectangle representing this top $hijg$. The line from b gives the position of the lower corner as seen in the plan at kl , but this corner is dotted; for in looking down on the prism the entire solid is between the point b and the eye; therefore, kl is dotted. Draw a horizontal line from b toward m , and where this





line intersects with ch , as at o , take a center and draw the arcs hn and gm . Vertical lines mp and nq mark the thickness of the prism as seen from the direction shown at the arrow (a). The corner c is shown in the side elevation (b) by a dotted line, while the corner a being near the eye and having nothing to obstruct it from view, is shown by a full line. Therefore, in these three drawings, we have three views of a simple solid, a combination of which gives not only its form but its actual position in space. It will be observed here that neither plan nor side elevation could have been drawn correctly without first drawing the front elevation; and while neither the plan nor side elevation show the angle to which the front elevation was inclined, nor a true length of its side, they may be placed in their proper positions and projection lines drawn so as to construct the front elevation and thereby show these proper dimensions. From this, we discover that if any two of these three views of an object—plan, front elevation, and side elevation—be given, we can place them in their respective positions and construct the third view.

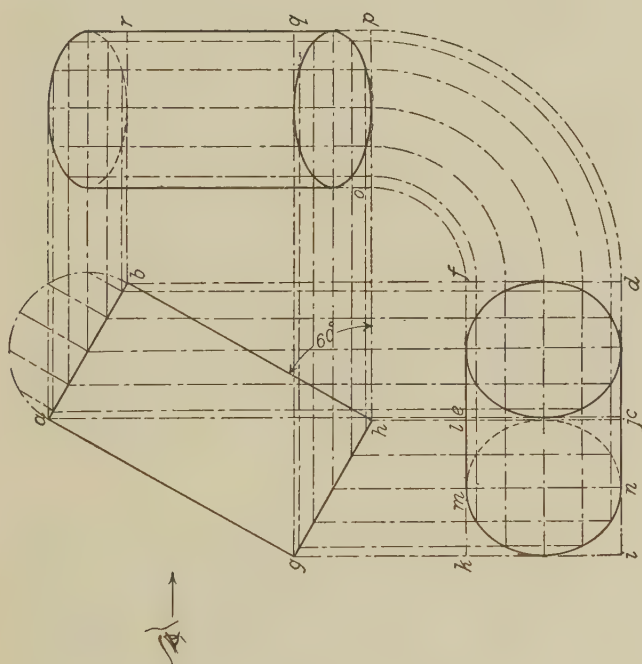
7. PROBLEM 15. Exercise II, Sheet III.—Problem 15 is identical in character with Problem 14, except that the object is an octagonal prism instead of a square one. The elevation on Sheet III, Exercise II, consists of a prism $1\frac{5}{8}''$ in diameter, inclined at the same angle, 60° , as the prism in Sheet II, with its dimensions ab , cd , etc., similar to those in Sheet II. The position of the lines fg and eh , however, can be found by applying principles given in *Geometrical Drawing* at the upper end cd as follows: From the points c and d , diagonals are drawn at an angle of 45° with cd intersecting at i . Then, with c and d as centers and ci as a radius, arcs are drawn intersecting cd at h and g , thus locating the points from which he and gf may be drawn completing the elevation of the prism. Vertical lines should now be dropped from each of the points a, e, f, b and d, h, g, c , indefinitely, toward jk . The horizontal lines lm, no, pq , and jk should be drawn spaced from l to m to k



to j , similarly to the spacing of a to e to f to b in the elevation, as these represent the angles on the sides of the octagonal prism. At the points where the vertical lines from d , h , g , and c intersect, the horizontal lines through m , o , q , and k , the lines of the octagon determining the top of the prism may be drawn; whereas, where the lines from a , e , f , and b intersect the lines through l , n , p , and j , the outlines of the base of the prism may be drawn. As the sides of the prism from f to b are beneath the entire solid, they are shown in the plan dotted, as at r , s , t , u . Now, with a center at x where the line ck intersects the line bv , the arcs mw , oy , qz , and kv are drawn. The vertical lines through the points so located represent the side of the octagon as it appears when viewed in the direction of the arrow (b) in the front elevation. The widths of the details at the top are determined by the width marked off at w , y , z , and v ; whereas, the heights, as shown by the foreshortenings, are determined by the spaces between lines dd' , hh' , gg' , and cc' . The surface $e'a'f'zy$ shows the bottom of the prism and is drawn entirely in full lines; while the surface $m'h'g'o'$ representing the top of the prism is drawn with the more distant side dotted, as the entire solid intervenes between this side and the eye.

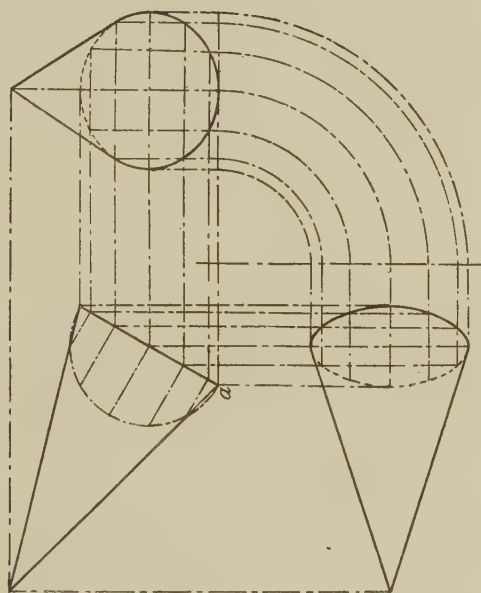
When a surface is inclined away from the eye, as is the base of this prism in the front elevation, its projection in the side elevation is said to be *foreshortened*, as it appears shorter or narrower than it really is. Thus, the octagonal base and top of the prism, as shown in the plan and side elevations, are foreshortened because they do not show their true dimensions in that position.

8. PROBLEM 16. Exercise II, Sheet IV.—In Problem 16, we have a hexagonal pyramid, the elevation of which is inclined with its base ab at an angle of 30° with the horizon, as shown. The point b of the base should rest on the horizontal center line, $1\frac{1}{4}''$ to the left of the vertical center line. The width of the base from a to b is $2''$, and its height to the apex c is $3\frac{1}{4}''$. To get the positions of the corners dc and ec ,



a semicircle should be drawn with the base ab as a diameter. The points f and g can be laid off on this semicircle with the radius of the semicircle subtending the arc as in the regular manner for drawing a hexagon within a circle. Lines drawn from f and g vertical to ab will locate the points d and e . Vertical lines through a , d , e , and b will establish points in the plan that will determine the outline of the base; while a vertical line through c will locate the apex in the plan at c' . In drawing the plan of the pyramid, note that the portion of the base that shows from e to b in the elevation is hidden when one looks down on it, and therefore appears in the plan dotted at $h s i$. The other side of the hexagonal pyramid $j k l$ appears as a full line. The width of the plan $j l$ is equal to the width of a hexagon inscribed in a circle whose diameter is equal to ab . The vertical line $m n$ is now drawn at any point intersecting with the base line $f o$; and, with m as a center, arcs are drawn with radii taken from the points where the lines $f h$, $k c'$, and $l i$ extended cut the vertical $m n$. Thus the points o , p , and q are located. These points correspond with the widths taken from the plan, whereas the height of each particular detail is projected across with the **T** square from the front elevation. Here, as in the case of the octagonal prism, the full base of the pyramid is shown and the sides cb and ce are shown dotted where the upturned base hides them from view.

9. PROBLEM 17. Exercise II, Sheet V.—Problems 17 and 18 are similar in principle to Problems 15 and 16, Problem 17 being a cylinder instead of a prism, and Problem 18 being a cone instead of a pyramid. To draw Problem 17, the elevation of the cylinder is drawn in exactly the same position as the elevation of the prism in Problem 15. The height of the cylinder is 3", while its width is $1\frac{5}{8}"$, the side $b h$ being inclined at 60° . Point h rests on the horizontal center line, $1\frac{5}{8}"$ to the left of the vertical center line. The shape and position of the top should be the first thing considered in drawing the plan, and therefore perpendicular lines should be dropped from a to c and from



b to *d*, marking the projected width of the visible end of the prism. The width of the prism $1\frac{5}{8}"$ is now laid off from *d* to *f*, *f* being located $1"$ below the horizontal center line. Lines being drawn forming the rectangle *c d f e*, we can draw within this rectangle an ellipse that will correspond to the foreshortened view of the top of the cylinder. Similarly, vertical lines dropped from *g* to *i* and *h* to *j* will form the rectangle *j i k l*, within which the lower surface of the cylinder, elliptic in shape, may be drawn. It will be observed that half the ellipse from *m* to *n* is shown dotted, as the solid of the cylinder is above it, thus preventing its appearing in full view. The side elevation of the cylinder is drawn by laying off the width *o p* and projecting the lines *g q* and *b r* to limit the depth of the ellipses that form the top and bottom. The lower ellipse, representing the bottom of the cylinder, is drawn in full; but the lower half of the upper ellipse, being hidden from view, is dotted.

PROBLEM 18. Exercise II, Sheet VI.—Problem 18 consists of a cone whose base is $1\frac{5}{8}"$ in diameter and whose height is $3"$. This cone can be inclined at any convenient angle, and the corner *a* should be on the horizontal center line, $1"$ to the left of the vertical center line. Work out this problem on precisely the same lines as Problems 15, 16, and 17 were worked, showing all the construction lines and how each point was located.

In working these problems in projections, do not at any time copy from the exercise any line of which the meaning is not understood, as such copying is a waste of time and is likely to cause serious difficulty in future work. These problems are explained as clearly as possible, but if there is any individual difficulty experienced write for further information after having tried diligently to work it out. These are not exercises in drawing, although we require them to be drawn accurately and neatly; they are problems in mathematics that one must be able to solve whenever they occur in regular practice, and the simple copying of these figures without any attempt to study the principle involved will do no good. Always know why certain lines are full lines and other lines

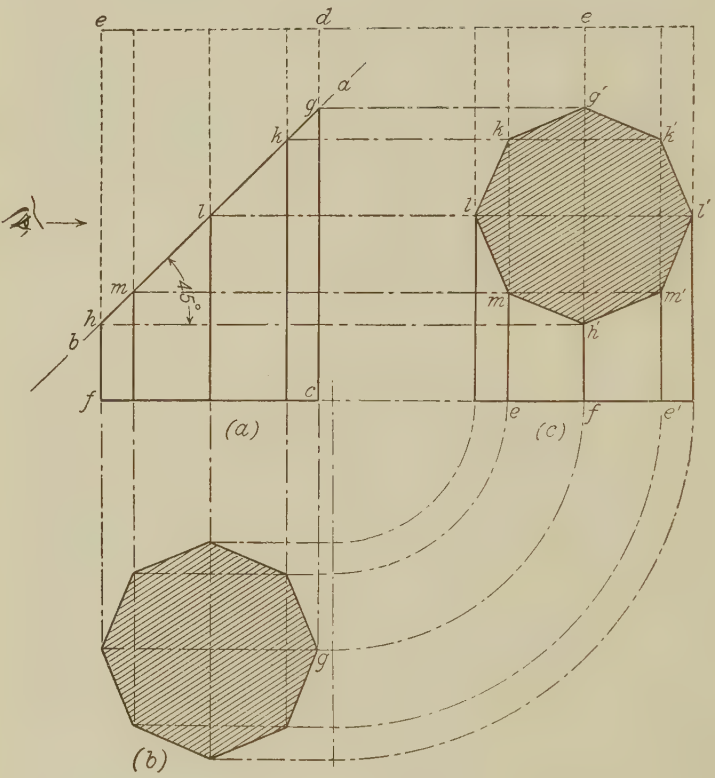
are dotted lines. By trial, it should be possible to draw any rectangular object in any position it may be placed so that a combination of its three views will express conclusively what that drawing stands for. In making drawings of cylinders and cones, it is sometimes advisable to consider them prisms or pyramids and work them out as figures having a polygon for a base with a large number of sides. After the various angles of the bases are then projected, it is a simple matter to sketch in the ellipses circumscribing the polygonal bases, thus forming the bases of the cones and cylinders accurately to scale. After finishing the problems in Exercise II, carefully letter the title PROJECTIONS, etc. at the top and the usual matter at the bottom of each sheet and send them in for correction.

SECTIONS

EXERCISE III

10. Exercise III consists of four sheets. The drawings are arranged on the sheets by drawing a horizontal and a vertical center line, and working from these lines. This exercise consists of the projection of an octagonal prism, a cylinder, an octagonal pyramid, and a cone. Each solid being cut by a plane ab , the purpose of this exercise is to demonstrate how to obtain the front or side elevation and plan of the surface of the cutting plane where it passes through the solid. For instance, in Sheet I, we have the elevation of the octagonal prism at $cdef$, the plane ab that passes through it entering one corner g and passing out the other corner h . The corner of the prism where the plane ab first enters is shown in the front elevation (a) at cd in the plan at g , and in the side elevation at ef .

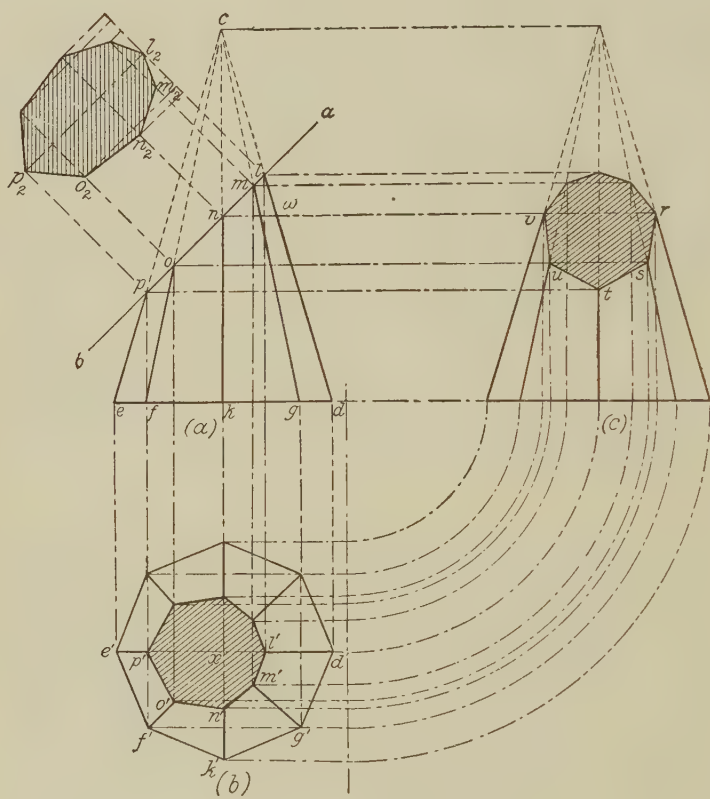
PROBLEM 19. Exercise III, Sheet I.—Draw the plan of the prism as an octagon whose center is $2\frac{1}{2}''$ below and $1\frac{1}{2}''$ to the left of the horizontal and vertical center lines, respectively. The diameter of the circle circumscribing the octagon is $2\frac{1}{4}$ inches. Draw the elevations (a) and (c) $3\frac{3}{4}''$ high and resting



on the horizontal center line of the sheet. Now draw the plane ab at an angle of 45° cutting both sides of the prism as shown, Exercise III, Sheet I.

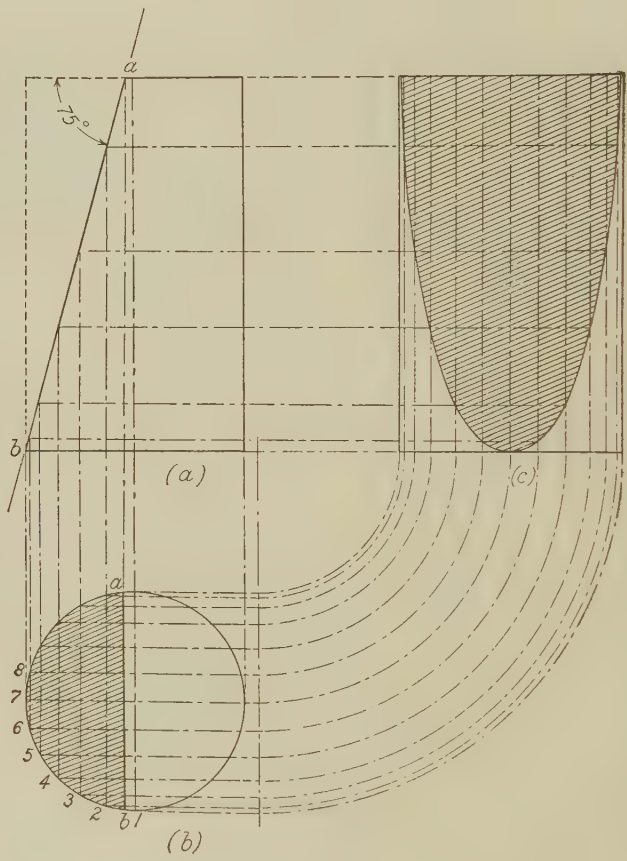
Where this plane passes through the successive elements or corners of the prism, as at g, k, l, m , and h , in the elevation (a), project horizontal lines until these lines intersect with the same elements in the elevation (c). The line ef in the front elevation (a) being the same as the line ef in the side elevation (c), we have, in (c), at g' , the upper point of the intersection, and at h' the lower point of the intersection of the plane with the prism; whereas, at k and k' we have the intersection of a line from k , in the elevation (a), with the elements of the prism ek and $e'k'$, the other points of intersection where the passing plane intersects the elements of the prism. Connecting the points g', k', l', m', h', m, l , and k by straight lines, presents the elevation of the truncated prism below the cutting plane ab . The surface of the section in this case happens to be a regular octagon, in elevation, because the plane ab is at an angle of 45° . The proportions of the plane of intersection will vary according to the angle of the cutting plane.

11. PROBLEM 20. Exercise III, Sheet II.—Problem 20 is similar to Problem 19 except that a pyramid is involved instead of a prism. Draw the center line of the plan and elevation $1\frac{1}{2}''$ to the left of the vertical center line of the sheet and locate the center of the plan $2\frac{1}{2}''$ below the horizontal center line. The outline of the plan of this figure is precisely the same as the outline of the plan in Problem 19. The elements, or corners, of the pyramid, however, show in the plan (b) as far as they exist below the cutting plane ab , and the plane of the upper surface of the truncated pyramid appears as an irregular octagon. Draw the octagonal plan (b) and the two elevations (a) and (c), the complete diameter of the base being about $2\frac{1}{4}''$ and the altitude of the elevation $3\frac{3}{4}''$. Draw the cutting plane ab at an angle of 45° with the axis of the pyramid. Where this plane intersects the elements of the cone dc, gc, kc , etc., let fall



perpendicular lines until they intersect the same elements represented in the plan as $d'x$, $g'x$, $k'x$, etc. Connecting these points of intersection presents the plan of the section cut by the plane ab . This plan should be an irregular octagon, as shown at l' , m' , n' , o' , p' , etc. To show the width of the section in the plan taken through the radial line kn of the elevation and its corresponding opposite edge, simply transfer the distance $n w$ from the elevation and locate it in the plan on either side of x , as at $x n'$. The side elevation (c) is now drawn by projecting lines from the points l , m , n , o , p to intersect with the same elements represented in elevation (c); the outline of the surface of intersection can now be drawn as shown at $rstu$, etc., Exercise III, Sheet II.

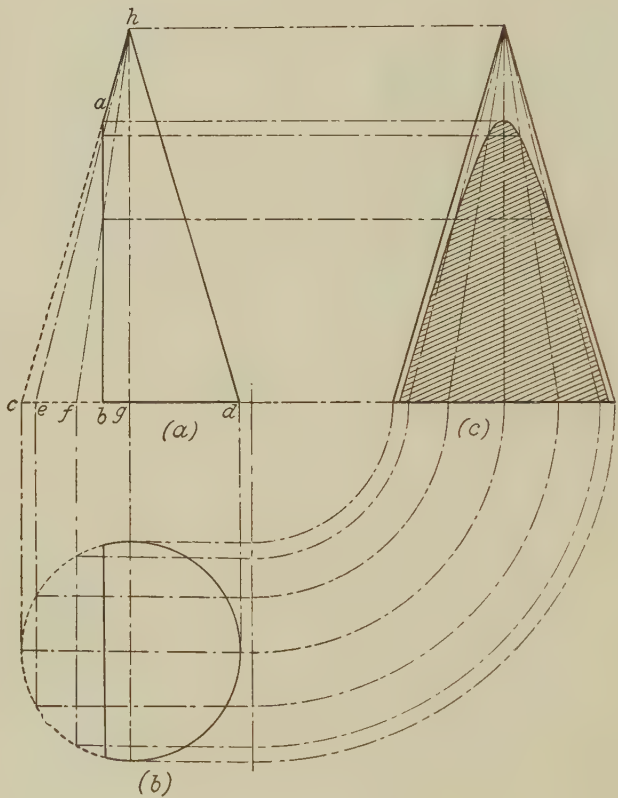
12. PROBLEM 21. Exercise III, Sheet III.—In Problem 21 is a cylinder that involves the same principles as found in Problem 19, except that the plan is a circle and the elevation a rectangle. The plan of this cylinder is a circle $2\frac{1}{4}''$ in diameter and its center is $1\frac{3}{4}''$ to the left of the vertical center line, and $2\frac{1}{2}''$ below the horizontal center line. The elevation is located on the horizontal center line, and is $3\frac{3}{4}''$ high. The cutting plane ab does not pass through both the top and bottom of the solid, but enters the top slightly to the left of the center at a and passes out at the lower left side, tangent to the circular base at b . This cutting plane ab is drawn at an angle of 75° , as shown in Exercise III, Sheet III (by a combination of the 45° and the 30° triangles). The side of the cylinder may now be considered as divided into a number of parts, and a vertical line through each part represents an element in the surface of the cylinder. For convenience, the circumference of the plan of the cylinder is divided into twenty-four parts, as 1, 2, 3, 4, etc. This can be readily done by a combination of the 60° , 30° , and 45° triangles. Lines from these points of division are projected through both elevations, as shown, and from the points where these lines intersect the line of the plane ab , in elevation (a), horizontal lines are drawn until they intersect, in the elevation (c), lines representing similar elements to those in (a).



These points of intersection, connected with a curved line will represent the outline of the surface of the plane cutting through the cylinder.

13. PROBLEM 22. Exercise III, Sheet IV.—Problem 22 is similar to Problem 21, except that the cutting plane ab is vertical, and passes through a cone so as to cut the base well toward the center. The cone is $2\frac{1}{4}''$ in diameter at the base and $3\frac{3}{4}''$ in altitude. To draw this figure, locate the center of the plan (b) $1\frac{3}{4}''$ to the left of the vertical center line and $2\frac{1}{2}''$ below the horizontal center line; and on the horizontal center line draw the two elevations in the usual manner. Divide the circumference of the base into twelve equal parts with a 60° and 30° triangle. Project lines from these parts until they intersect the base of the cone in the elevation (a). From the points of intersection c, e, f , etc., to the vertex of the cone, draw lines eh, fh , etc. and consider each as an element of the cone. Where the cutting plane intersects one of these elements, draw a horizontal line until it intersects a similarly drawn element in the elevation (c). This similar element can be determined by following from the point of intersection in elevation (a) down to the base of the cone, vertically to the plan, and around the quarter circle (c). The points located on (c) can now be connected by a curved line; the surface will be a hyperbola and will appear in full and true dimensions. The projections of the cutting surfaces in Problems 19, 20, and 21, however, are inclined away from the eye at the same angle that the cutting plane is; therefore, they are foreshortened and do not present their true dimensions in the elevation. In order to accomplish these true dimensions it is necessary to proceed as follows:

On Sheet II where the cutting plane ab intersects the elements of the pyramid at l, m, n, o , and p , lines are drawn perpendicular to ab , as ll_1, mm_1, nn_1 , etc., and l_1p_1 is drawn at any convenient point parallel to ab . Then, from the plan (b) the widths are laid off each side of l_1p_1 as a center line. Thus, the distances from the line $e'd'$ in the plan (b) to the points $m'n'o'$ and p' are laid off above and



below l, p , in the elevation (a) as shown at m, n, o , and p . These points, being connected up by straight lines, outline an irregular octagonal surface showing the true form of the upper side of the pyramid as cut by the plane $a b$.

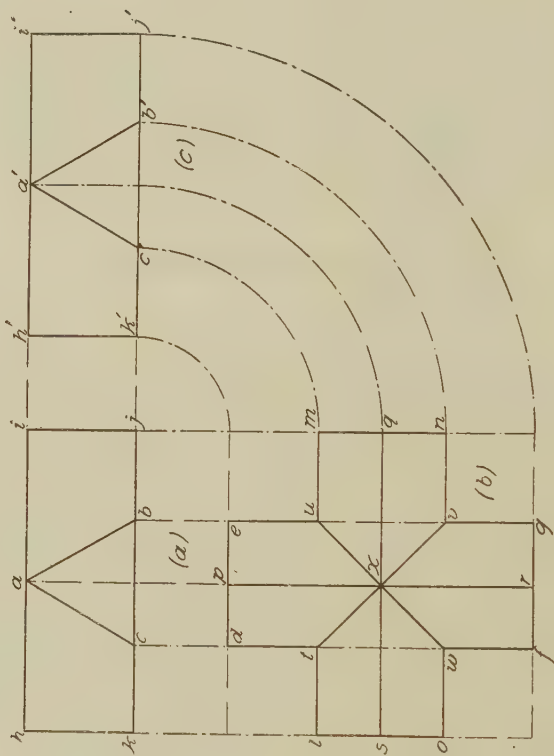
If the solid were a cone, the process would be the same, except in connecting the various points so located a continuous curved line would be used, thereby presenting a parabola, hyperbola, or an ellipse, according to the position of the cutting plane. The title of this exercise SECTIONS should be carefully placed at the center of the top of each sheet, and the other lettering in the usual places and all four sheets mailed FLAT at one time for correction.

INTERSECTIONS

EXERCISE IV

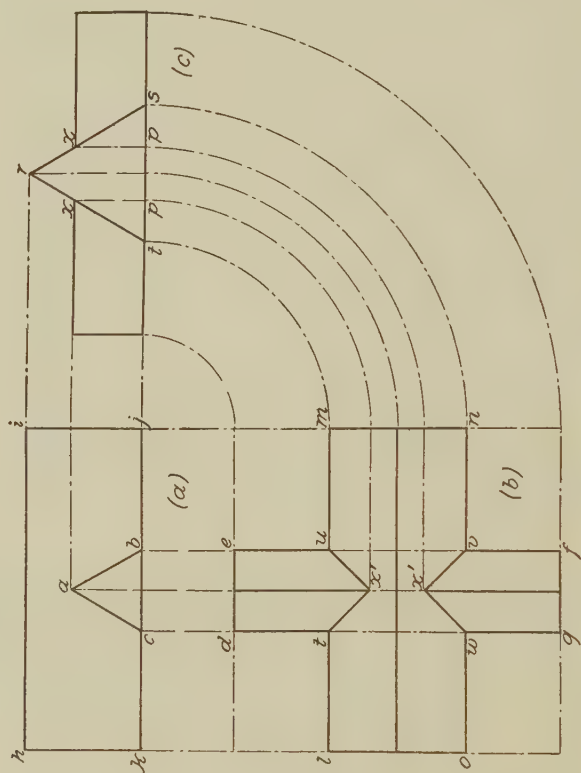
14. The six sheets for Exercise IV contain one figure each, and may be laid out by the method of vertical and horizontal center lines, as explained for previous exercises. This exercise consists of six problems in the intersections of solids. Sheet I shows the intersections of two triangular prisms of the same size and Sheet II the intersection of two triangular prisms of different sizes. Sheet III shows the intersection of two irregular pentagonal prisms and Sheet IV the intersection of an irregular pentagonal prism with a triangular prism. Sheet V shows the intersection of two semicylinders of equal diameters, while Sheet VI shows the intersection of two semicylinders of different diameters. The purpose of these six problems is to illustrate methods by which the lines of intersection of any two slopes may be obtained, and at the same time to present geometrical solids as illustrations that will conform as nearly as possible to actual architectural and design problems that may arise.

PROBLEM 23. Exercise IV, Sheet I.—To draw Exercise IV, Sheet I, commence by laying out the end elevation



of the triangular prism abc , its point a being $2''$ to the left of the vertical center line, and $2\frac{1}{2}''$ above the horizontal center line. The sides of the prism are $1\frac{1}{4}''$ each and the angles each 60° . The plan of this prism $defg$ is then drawn below the base cb as shown, the length df being $3''$. The side elevation of the other prism $hijk$ is then drawn as shown, the length hi being $3''$; the plan of the second prism is shown at $lmno$. It will be observed in the plan that the upper edges of the prisms sg and pr intersect at the point x , while the lower edges of the prism df , lm , etc. intersect at the points t, u, v, w . Therefore, lines drawn from t, u, v , and w to where the upper edges intersect will be the lines of intersection, as shown at tv and uw . The elevation (c) is precisely the same as the elevation (a); but in this case, the triangle $a'b'c'$ represents the end view of the prism $hijk$ in (a), and the rectangle $h'i'j'k'$ in (c) represents a side elevation of the prism abc in (a). It will appear from this that when two prisms whose sides incline at equal angles intersect each other at right angles, the lines of intersection will be at 45° with the axes of the prisms. Thus, in (b), we have two triangular prisms whose sections contain similar angles; therefore, the lines of intersection tv and uw are at 45° with the axes of the prisms.

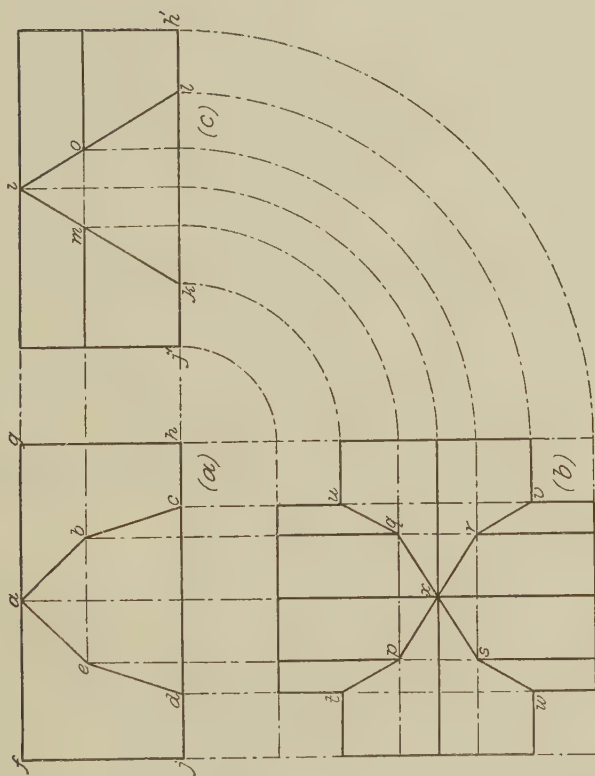
15. PROBLEM 24.—In Problem 24, the same process is carried out except that the two prisms are of different sizes. Here the elevation of one prism abc is drawn with the point a $2''$ to the left of the vertical center line, and $2\frac{1}{4}''$ above the horizontal center line. The sides ab , bc , and ca are each $\frac{3}{4}''$. The plan of this prism is then drawn as shown at $defg$, the side ef being $3''$ long. The side elevation of the other prism $hijk$ is then drawn as at (a), the side hi being $3\frac{1}{8}''$ long; the plan of this prism is shown at $lmno$. In (c) the end elevation of the larger prism and the side elevation of the smaller prism is drawn, the sides rs , st , and tr being $1\frac{1}{4}''$ each. The points x show how high the smaller prisms extend on the larger. This point, being carried down to the base line of the prism at p and swung into the



plan, with point j of (a) as a center, gives the point x' in the plan (b), which is the point where the upper edge of the smaller prism intersects the side of the larger prism. Lines from t, u, v , and w , where the base line intersects, to the points x' in the plan, give the lines of intersection in the plan. These lines of intersection, as in the previous problem are at an angle of 45° with the axis of the prism, because both prisms have the same slope or angles.

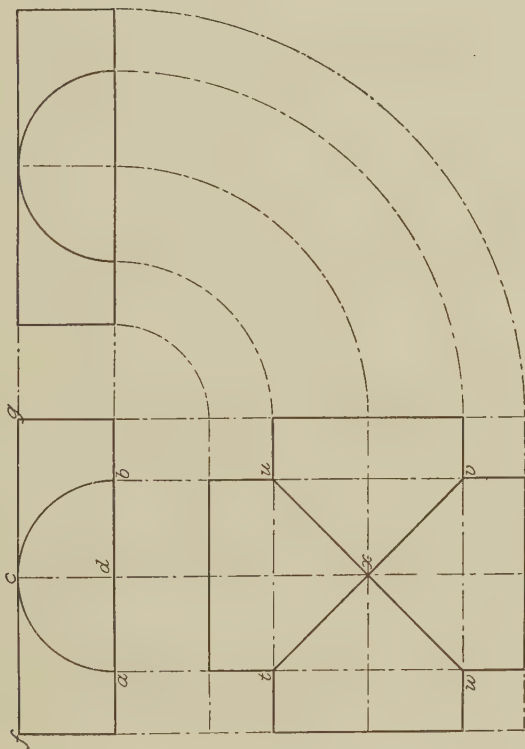
16. PROBLEM 25. Exercise IV, Sheet III.—Problem 25 is precisely the same as the two preceding, except that it contains two irregular pentagons. Commence by drawing the pentagon $abcdl$ with its point a $2''$ to the left of the vertical center line and $2\frac{3}{4}''$ above the horizontal center line. The base dc is $1\frac{7}{8}''$ long; and the distance lb is $1\frac{5}{8}''$. The sides la and ba are inclined at angles of 45° . The side elevation of the other prism at $ghjfl$ is $3''$ long and $1\frac{1}{2}''$ high from j to f , and the lines of intersection, as shown in (c), are precisely the same as those of the previous problems. The side elevation of (c) is similar to (a) and the distance hj' between them is $1''$. In drawing the plans of these two prisms, lines are projected from the front elevation (a) and side elevation (c), as shown in the exercise; the points of intersection of lines from d and c in the elevation (a) and from k and l in elevation (c) when projected into the plan (b) locate the intersection of the bases at t, u, v, w . The intersection of the upper edges or angles occurs in the plan (b) at x , as may be seen, and the intersection points l and b in (a) and of n and o in (c) occur in the plan (b) at p, q, r, s . Lines drawn through u and t to w and v , therefore, give the lines of intersection, and again we find that these lines are at an angle of 45° with the axes of the prisms, as both intersecting slopes are at the same angle.

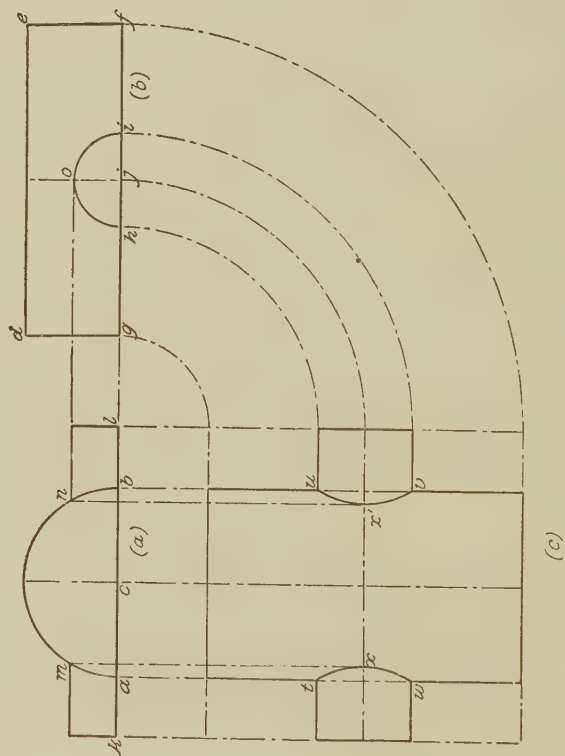
17. PROBLEM 26. Exercise IV. Sheet IV.—In Problem 26, we have the intersection of a pentagonal prism similar to that in Exercise IV, Sheet III, with a triangular prism similar to that in Sheet I. It will be here observed, on looking at the plan (b), that the lines are no longer at an angle of 45°



owing to the fact that the slopes of the triangular prism are different from those of the pentagonal prism. The elevation (a) is similar to that in Sheet III (a), the point *a* being 2'' to the left of the vertical center line and $2\frac{3}{4}$ '' above the horizontal center line. The line *fg* is 3'' long. In the elevation (c), we have the end view of the triangular prism and the side view of the pentagonal prism. The sides *ik*, *il*, and *kl* of the triangular prism are $1\frac{3}{4}$ '' long; the lengths *j'h'* and *j'h* are 3'' each; and points *h* and *j'* are 1'' apart. When the plan (b) is drawn, it is found that the upper edge of the triangular prism and the upper edge of the pentagonal prism intersect at *x*, whereas the bases of the two prisms intersect at *t*, *u*, *v*, and *w*. In (c), the edges of the pentagonal prism intersect the sides of the triangular prism at *m* and *o*, and swinging these points around into the plan (b) (with a center at *h*), we find that they intersect with the projected lines from *e* and *b* in (a) at *p*, *q*, *r*, and *s* in (b). Lines drawn from *t*, *u*, *v*, and *w* to *p*, *q*, *r*, and *s* give in the plan the lines of intersection of the lower slopes of the pentagonal prism, *bc* and *ed* of (a) with the triangular prism; and lines drawn from *p*, *q*, *r*, and *s* to the point *x* give the lines of intersection of the slopes *ab* and *ae* in (a) with the triangular prism, thus completing the intersection as it shows in plan.

18. PROBLEM 27. Exercise IV, Sheet V.—In Problems 27 and 28, the principles are identical to those in Problems 23 and 24, except that the solids are semicylinders instead of prisms. The diameter *ab* of the cylinder is 2'' and the center *d* is located 2'' to the left of the vertical center line and $1\frac{7}{8}$ '' above the horizontal center line. The length of the intersecting cylinder *fg* is 3'' and in plan we have the points *t*, *u*, *v*, and *w* where the lower edges intersect. The lines of intersection *uw* and *tv* are at an angle of 45° with the axis of the cylinders because the curvature of each is the same, namely, that of a circle. Had one of these been an ellipse and the other one a circle, the line of intersection would have been irregular; but since they are both arcs of circles or both arcs of the same ellipse, the lines of intersection will be at 45° with the axis.





PROBLEM 28. Exercise IV, Sheet, VI.—This problem is similar to Problem 24. The diameter of the semicylinder ab is the same as in Exercise IV, Sheet V; the center is located as in Sheet V, and the side elevation $defg$ is drawn to the right, the length de being 3". The smaller semicylinder hi is only $\frac{7}{8}$ " in diameter, and its center j is on the base and directly in the center of gf ; g is 1" to the right of l . The side elevation of the smaller cylinder kl in (a) is 3" long. The plans of the two cylinders are now drawn at (c) and lines projected from the points a and b of (a) and h and i of (b) intersect at t, u, v , and w , of (c). Project lines from the top of the smaller cylinder m and n in (a) and o in (b) and they will intersect at x and x' in (c). The lines tx, wx, ux' and vx' are the lines of intersection of the two semicylinders. Each sheet of this exercise is to be lettered as were the previous sheets, with title (in this case INTERSECTIONS), exercise number, sheet number, etc., and all the sheets then sent to the Schools for correction.

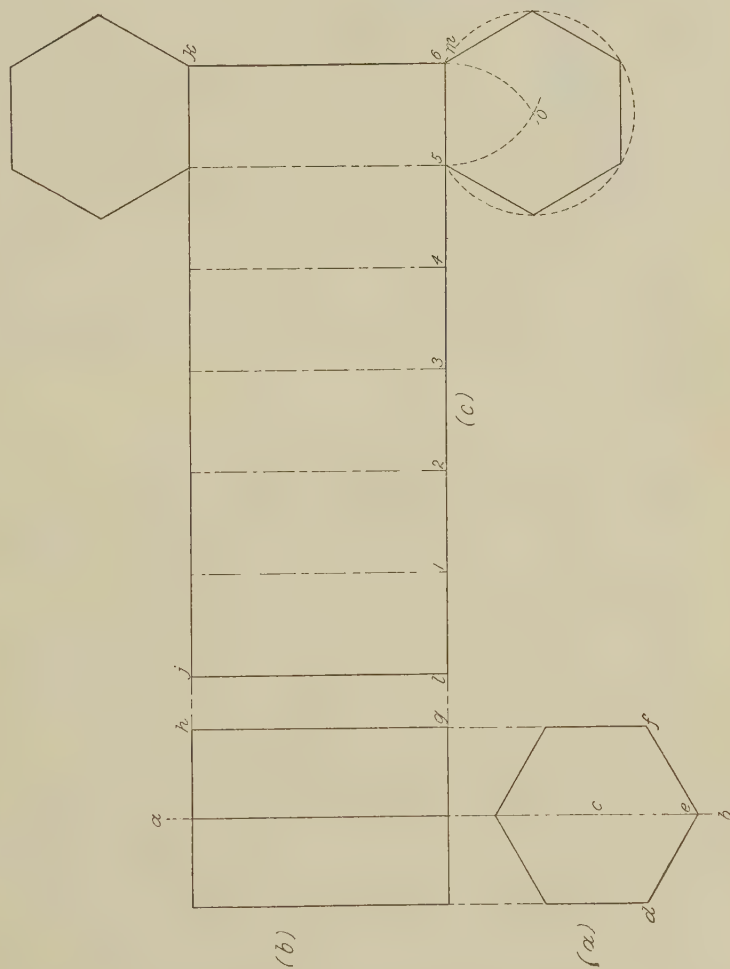
These problems on projection drawing contain all the principles that will be required in ordinary architectural or design drawing. They will appear in different forms as the studies are continued, but the application of the principles of these simpler problems is all that will be required, and it is absolutely necessary that you should be thoroughly familiar with these applications and with every form of the problem herein set forth, as any misunderstandings will lead to further difficulty. Therefore, do not hesitate to ask for any information in connection with these projections and intersections, relative to points that are not clearly understood.

DEVELOPMENTS

19. It is frequently necessary, in design work, to prepare a drawing that is to be worked out in some decorative medium or material to fit the curved or spherical surface, or to extend around an angle at the corner of a building or utensil. In order that all parts of the design may be harmonious and fit together properly, it is necessary that the design should be prepared on a flat surface that is equal in area and proportion to the curved or combined surfaces of the object it is to adorn. In order to accomplish this, we take the surface of our object and unroll it, or develop it, as it is termed, so that it lies out perfectly flat.

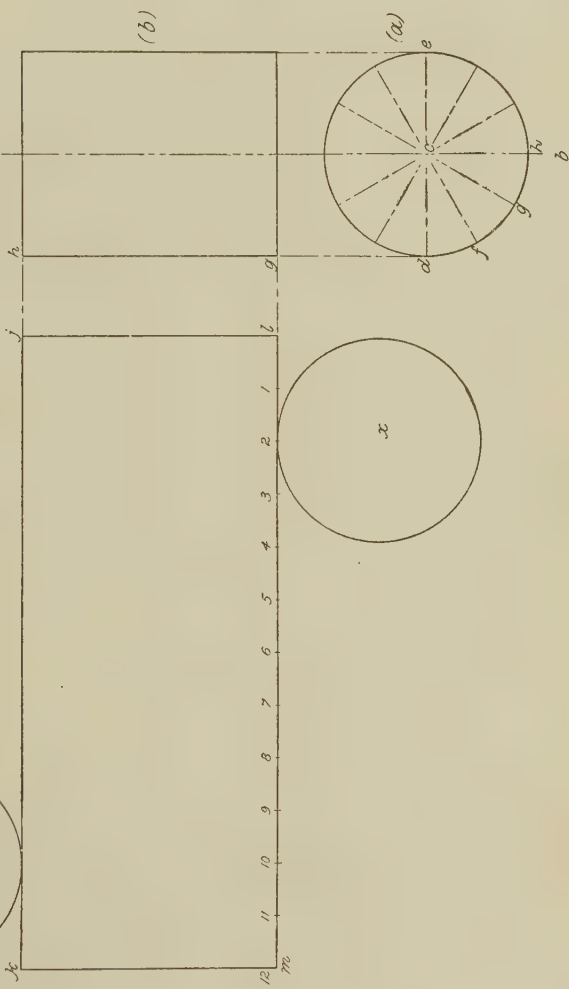
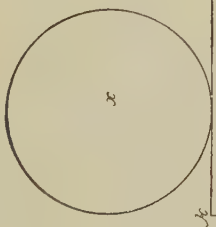
(*a*) and (*b*) on the first sheet of the exercise show the plan and elevation of a hexagonal prism, while at (*c*) is shown the development of its surface wherein each of its sides is shown as a single panel and at the end a hexagonal top and base. This form could be cut out of paper or sheet metal, folded on the vertical lines dividing the panels and horizontal lines separating the six panels from the top and bottom, and be bent into a perfect hexagonal prism of the form shown in plan of elevation at (*a*) and (*b*). The exercise on Developments will consist of four sheets, each $9'' \times 12''$ outside and $8'' \times 11''$ inside the border line.

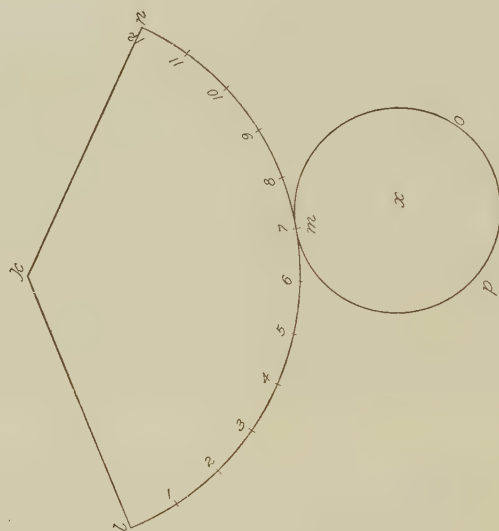
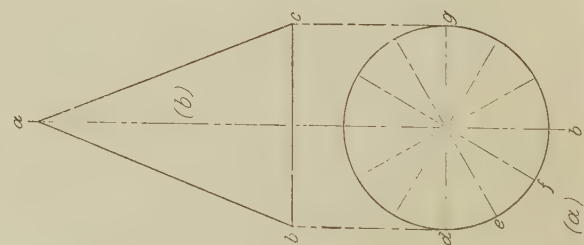
20. PROBLEM 29. Exercise V, Sheet I.—Turn the sheet horizontally and draw a vertical line $ab\ 2''$ to the right of the left border line; this will be the center line of the plan and elevation of the prism. $1\frac{1}{2}''$ above the lower border line and on the center line ab , locate the center (*c*) of a circle $2''$ in diameter, within which describe the hexagonal base def , etc. Project lines from *d* and *f* into the elevation, making the height of the prism $gh\ 2\frac{1}{2}''$. Draw indefinite lines jk and lm so that the distance jl will be equal to the height hg . Take any side of the hexagon, as ef , and with a pair of dividers



mark off ef on the line lm six times, locating the angles of the sides of the prism at 1, 2, 3, etc. until six sides have been laid off. Through the points so located draw vertical lines until the six panels are completed. With the corners marked 5 and 6 as centers, with the compasses set at a distance equal to ef of (a), strike arcs intersecting at o ; this point will establish the center of a hexagon whose sides are equal to the distance 5-6. Draw this hexagon as the base of the prism and draw a similar one as the top. Thus, $jlmk$ may represent the development of the surface of the sides of the hexagon, and the two hexagons at the top and bottom will represent the surface at the top and bottom of the hexagonal prism. Ink in, carefully, the plan and elevation of the prism and the development of its sides, top and base. The construction lines may be left in pencil, and all lettering omitted except the title, exercise number, sheet number, name, date, etc.

21. PROBLEM 30. Exercise V, Sheet II.—Problem 30 is the development of a cylinder whose plan is shown at (a) and elevation at (b). To draw this problem locate a center line ab for the plan and elevation $2''$ to the left of the right border line, and $1\frac{1}{2}''$ above the lower border line locate the center c of a circle $2''$ in diameter that is to represent the plan of the base. Project from the sides of this circle de its width into the elevation, making the height gh $2\frac{1}{2}''$. Divide the plan into twelve equal parts, as shown at $d f g h$, etc., by means of the 30° and 60° triangles. Draw two indefinite lines jk and lm , making the distance jl equal to the height of the prism hg . With the compasses, measure off one of the twelve subdivisions of the plan, as df , and lay it off along the line lm twelve times as indicated at 1, 2, 3, 4, etc. This will represent, approximately, the circumference of the cylinder rolled out. Draw the lines jl and km . From divisions 2 and 10, draw vertical lines below and above the developed surface; and with a radius of $1''$ and centers on these lines at x , describe two circles tangent to the developed surface that will represent the development of the top and base of the cylinder.

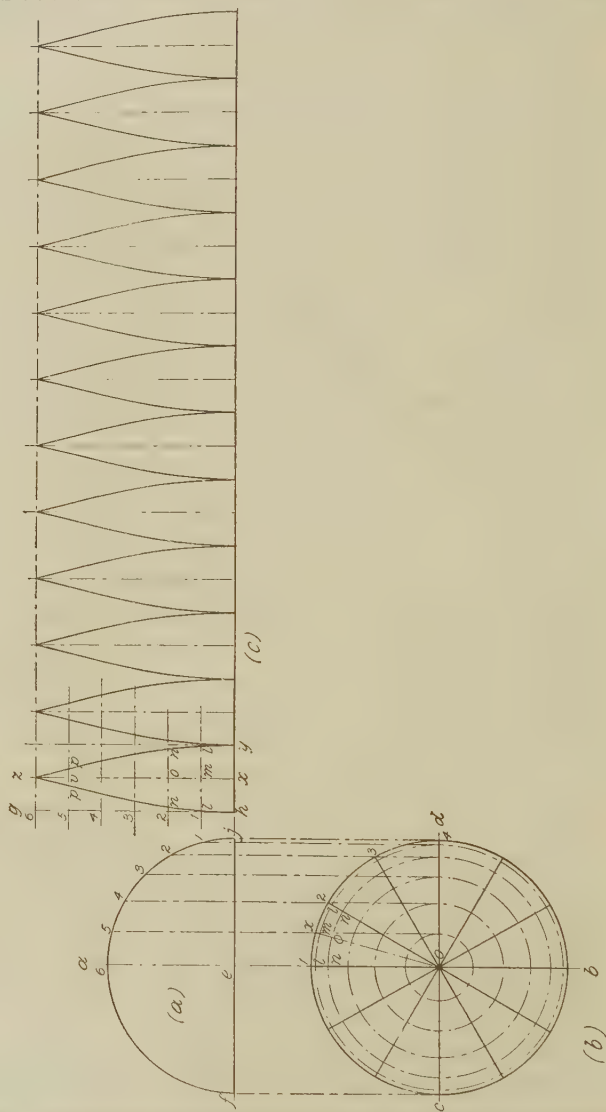




Ink in the plan, elevation, and development of this cylinder, but omit all lettering except the title, name, date, etc.

22. PROBLEM 31. Exercise V, Sheet III.—In Problem 31, a cone is represented, but the principle is exactly the same whether the figure is a cone or a pyramid. The center line ab of the plan and elevation is drawn 2'' to the right of the left border line, and the center of the circle representing the base is $1\frac{1}{2}$ " above the lower border line. The elevation can then be drawn with its base about 3'' above the lower border line, making the altitude of the cone $2\frac{1}{2}$ ". Divide the circumference of the cone into twelve equal parts in precisely the same manner as was done with the base of the cylinder on Exercise V, Sheet II, as at def , etc. Now, in any convenient place, draw a line kl equal to the length of ac one of the elements of the cone. With k as a center and a radius ac , draw, indefinitely, the arc lmn ; and on this arc lay off twelve subdivisions, as shown at 1, 2, 3, etc., each one equal to de of the plan a . From the twelfth subdivision draw nk . At any point within the subdivisions draw a tangent circle mop whose center x is 1'' beyond the arc lmn and whose diameter is 2''; $lmnk$ will then represent the development of the side of the cone and $m p o$ the development of the base. Ink in the plan, elevation, and developed surfaces, leaving the construction lines in pencil, but omit all lettering except the title, date, name, etc.

23. PROBLEM 32. Exercise V, Sheet IV.—Problem 32 is the development of a hemisphere. This is somewhat more complicated than either of the two previous problems but in no way more difficult if the principle is understood. After drawing the border line $8'' \times 11''$, locate the center line ab $1\frac{1}{2}$ " to the right of the left border line, and with the center o 2'' above the lower border line, and with a radius of $1\frac{1}{4}$ " draw the circle $c b d$ representing the plan of the hemisphere. On the line ab at e , 4'' above the lower border line, locate the center of the semicircle faj whose radius is $1\frac{1}{4}$ ". As the surface of this solid is curved in two directions, it is practically impossible to develop it in one unbroken surface;



therefore, it must be considered as a figure with a number of flat sides and developed accordingly, as follows:

Divide one-half the semicircular elevation aj into six equal parts, as shown at 1, 2, 3, 4, 5, and 6 in the elevation (a), and draw the line $gh\ 3''$ to the right of the border line. On gh lay off the distances $h\ 1$, $h\ 2$, $h\ 3$, etc. so that the individual spaces 1-2, 2-3, 3-4 will be equal to 1-2, 2-3, 3-4 in the elevation (a). Through these subdivisions, on the line hg , draw horizontal lines. Now divide the circumference of the plan (b) into twelve equal parts as shown at 1, 2, 3, etc. Subdivide any one of these parts, as 1-2, at x . With the compasses, lay off the distance $1x$ from the base of the line gh in (c) so that hx and xy will be equal to $1x$ and $x2$ in the plan (b). Draw the vertical line xz . Project lines from 1, 2, 3, 4, etc. in elevation (a) to intersect with cd the diameter of the plan (b), and at these points of intersection draw concentric circles as shown, each circle representing the horizontal diameter of the section of a sphere at the points indicated at 1, 2, 3, etc. of the elevation. In the plan, the width $1x$, $x2$ corresponds to the width hx and xy in the development (c), but we must now lay off lm , which is taken from the first concentric circle in (b), and make it equal to lm in the development (c) and no on the second concentric circle equal to no in the development (c), and so on with each concentric circle up to the last where the fifth concentric circle is laid off in (c) as shown at pv . Through the points thus located, a curve $hlnpz$ is drawn on one side and $ylnpz$ on the other. This triangle hyz , with the curved sides hz and zy , represents one of the twelve forms that will exactly bend over the surface of the hemisphere; and by repeating this form twelve times, as shown, we have, as in (c), the development of this hemispherical surface. Ink in the plan, elevation, and development, showing the subdivisions in the circumference of the plan and semi-circumference of the elevation. Leave all construction lines in pencil, or dot them in ink, and omit all lettering except the title, name, date, etc.

Particular attention must be given to these problems in order that they may be fully understood, as they constantly

reappear in connection with problems in design, and their practical application must frequently be made use of.

24. The method of developing the surfaces of a sphere, cone, or cylinder by dividing the sides into any given number of equal parts is not absolutely accurate, inasmuch as each part, when taken off the circle, is not the true length of the arc but its chord, and the development of the surface therefore is somewhat shorter or smaller than the actual length. For practical purposes, however, this is usually sufficient, as the greater number of subdivisions will bring greater accuracy of length; but where exactitude is required, as in certain sheet-metal work, the true length of the curve should be calculated.

The circumference of a circle is slightly more than $3\frac{1}{7}$ times its diameter, therefore by multiplying the diameter by $3\frac{1}{7}$ we have at once the length of the developed circumference of the circle. Taking the cylinder drawn on Exercise V, Sheet II, we find that a circle 2" in diameter should have a circumference of $6\frac{2}{7}$ ". A comparison of this true length with the length on Sheet II will give an idea of the slightness of the inaccuracy of this method. When the problems on these sheets are all completed, each sheet should be lettered with the title DEVELOPMENTS and other lettering in the proper places and all the sheets sent to the Schools for correction.

PERSPECTIVE PROJECTION

25. The essential difference between the representation of an object in a projection drawing and its appearance in a perspective drawing is that in the former all the parallel lines bounding surfaces are drawn parallel in the projection to the actual size or scale of the object for which they exist. In perspective, however, the parallel lines bounding the edges of surfaces converge toward a point unless these surfaces are directly in front of and parallel with the eye.

In Fig. 1 is shown the projection drawing of a cube, wherein it can be seen from the plan (*a*) that the corner *e* of the cube is toward the observer and its sides recede at angles of about 45° toward the right and left, and in the elevation (*b*) two sides of the cube are seen—the corner *e* separating them.

In Fig. 2, the same cube is shown in perspective, and the sides that were parallel in Fig. 1 are seen to converge—*ab*, *cd*, and *ef* converging toward the right, *db*, *ca*, and *eg* converging toward the left. It is therefore evident that if we know the position of the several points toward which these lines converge, we can draw an object in perspective and represent its details very much as it would appear to the eye.

The points toward which parallel lines converge are called **vanishing points**, and their positions are dependent on the position of the object to which they pertain. The more distant the object is placed from the eye, the farther separated are the two principal vanishing points. The vanishing points of all horizontal lines are on a level with the eye; and the horizontal straight line passing through them all is called the **horizon**. Whenever in a drawing an object is said to be above or below the horizon, above or below the level of the eye is meant; in one position it is looked up to, and in the other position it is looked down on.

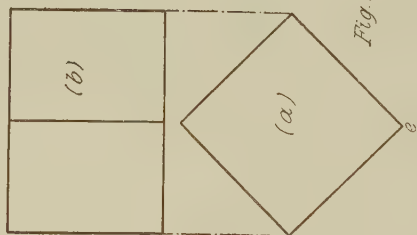


Fig. 1

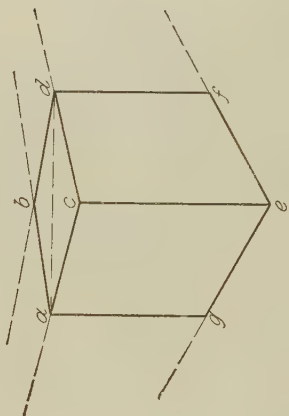


Fig. 2

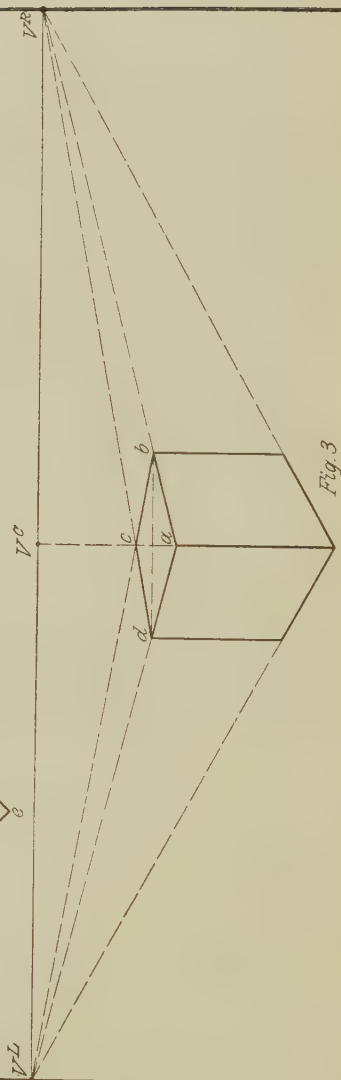
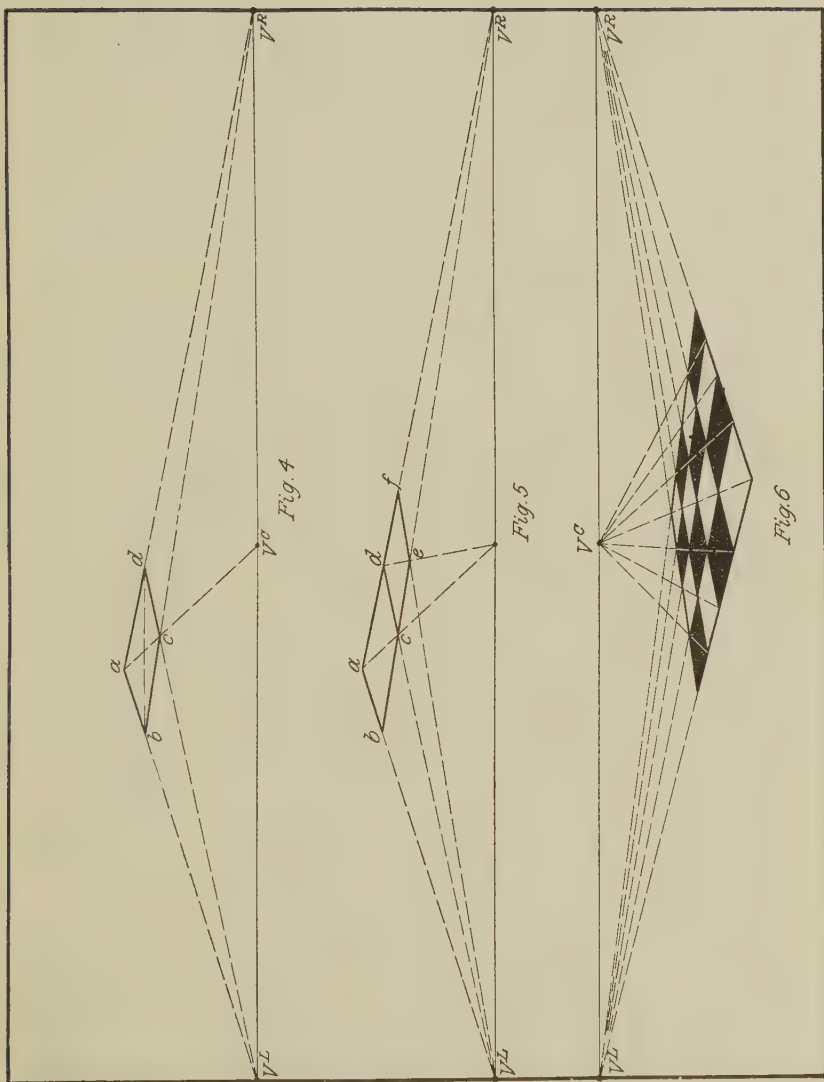
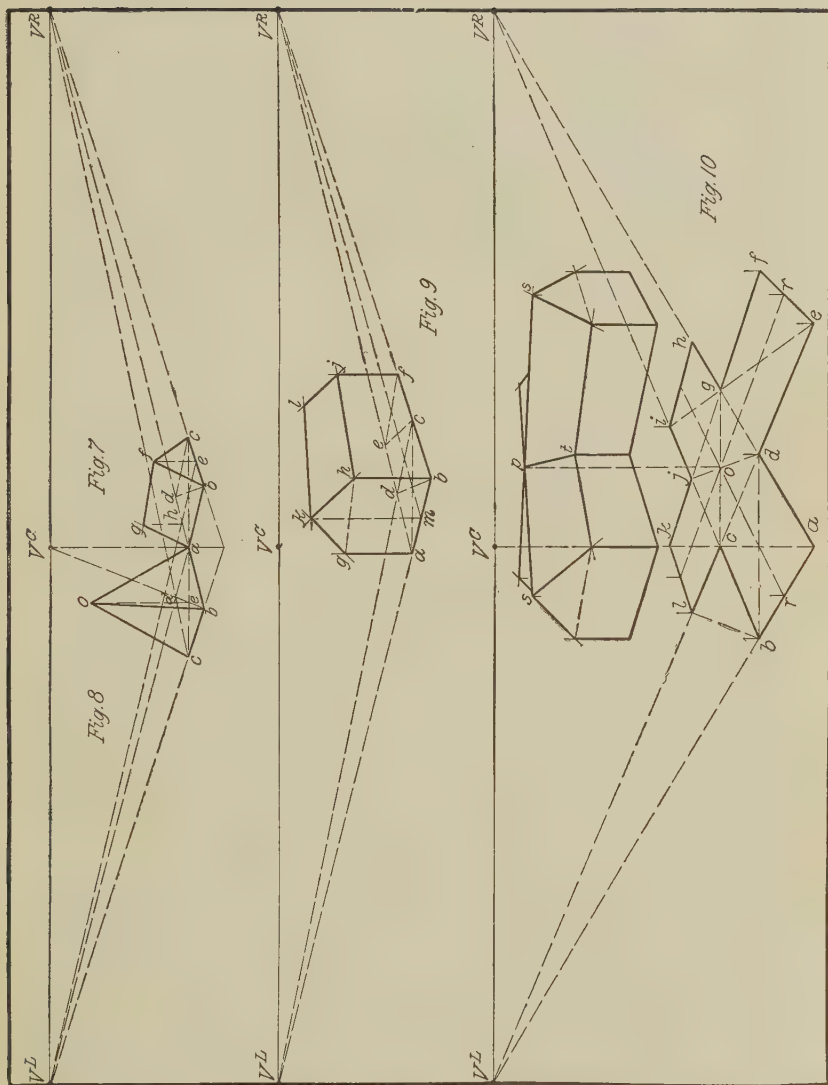


Fig. 3



For practical purposes, it may safely be assumed that the two principal vanishing points are twice as far apart as the eye is from the object. If, then, it is desired to draw the perspective of a 4-inch cube as it would appear 24 inches from the eye, proceed to lay out the vanishing points 48 inches apart, as in Fig. 3, V^R being the vanishing point toward the right and V^L being the vanishing point toward the left. The position of the cube relative to the horizon affects its appearance only so far as we see more or less of its top or base. In Fig. 3, it is considerably below the horizon and therefore a full view of the top is obtained. Now, this top $abcd$ is in reality the perspective of a square, and if a diagonal is drawn through the square from a to c and prolonged until it intersects the horizon, we have at V^C the vanishing point of the diagonal of the square; or, in other words, the vanishing point of lines at an angle of 45° with the principal lines; or, still simpler, the vanishing point of all horizontal lines perpendicular to the horizon. The other diagonal of the square bd is parallel to the horizon and has no vanishing point, as no matter how far it might be prolonged it will not intersect with the horizon at any point. With these simple facts thoroughly understood, one can always draw, in perspective, a square, as the vanishing points of the sides can be placed any convenient distance apart, and the vanishing point of the diagonal will always be just half way between. Thus, assuming a convenient point a , Fig. 4, lines can be drawn to V^L and V^R and to V^C , and then from some point b another line can be drawn to V^R intersecting the diagonal at c . The line from V^L through c to d will complete the perspective of the square, and bd the other diagonal, if wanted, can be drawn parallel to the horizon. If from the point d another line is drawn to V^C , a diagonal de , Fig. 5, of another square adjacent to the first is drawn; a line from V^L through e to f completes the second square. Thus it is easily seen that any number of adjacent squares can be completed by means of the diagonals and these three vanishing points.

In Fig. 6 is shown a checkerwork drawn entirely by this means. Pyramids, prisms, and other geometrical solids can



be represented by first drawing the perspective of their bases and then erecting over these bases the outlines of the perspective elevations.

In Fig. 7, at $abcd$, is shown the perspective of a square and of its diagonals. A line from V^L through the intersection of these diagonals marks at e , the center of the side bc . On a perpendicular line through e , the apex of the triangular end of a prism may be located at f , and fb and fc are drawn, and from f toward V^L a line is drawn marking the upper edge of the prism fg . The point g is directly over h , where a line from e to V^L intersects ad .

In Fig. 8, at $abcd$, is a square whose diagonals intersect at l . Over e , erect eo , the axis of a pyramid; lines drawn from a , b , and c , meeting at o , complete the perspective of a right square pyramid.

In Fig. 9 is shown, at $abcd$, a square and, at $cdef$, an adjacent and similar square. Perpendiculars erected over a , b , and f form the sides of the perspective view of a rectangular solid. From any point over b , as at h , lines are drawn to V^L and V^R , establishing the upper edges of the rectangular sides at hg and hj , and a line from V^R through the intersecting diagonals marks the center of the side ab at m . The perpendicular mk contains an end of the upper edge of the prism at k . Draw gk and hk to form this triangular end m , and then draw kl toward V^R and jl approximately parallel to hk . Thus, in Fig. 9, is formed the perspective of a rectangular solid supporting a triangular prism—a problem precisely similar to the perspective of a small gabled house.

In Fig. 10 are shown two intersecting rectangular solids supporting two triangular prisms, a problem similar to the roof of a four-gabled house. The plan in this case is drawn far enough below the elevation to be entirely separate. It consists of a series of five similar squares, $abcd$, $defg$, $ghij$, etc.; the diagonals of the central square intersect at o , and by erecting a perpendicular from this point of intersection the point p is established where the ridges or upper edges of the prisms intersect; the points r in the plan are obtained by drawing the lines from V^L and V^R through o , thus establishing

the positions of ends of the ridges in the elevation above at s . The line $p t$ between the intersection of the ridges and the intersection of the base is a *valley* or line of intersection.

In Figs. 4 and 5, it was observed that the material difference in the appearance of an object was effected by the position above or below the horizon. Many objects, such as chairs, tables, stools, boxes, etc., are habitually seen below the eye; other objects, such as doors, windows, bookcases, mantels, etc., are seen on a level with the eye or partly above and partly below, but roofs, towers, spires, etc. are habitually seen entirely above the eye. However, there are occasions when one stands on a high building and looks over a city, or on the side of a hill and looks over the valley, and the entire view is below the eye. Such a view as this, when rendered in perspective, is usually called a *bird's-eye view*; and in architecture the bird's-eye view is of vast importance, as it enables us to lay out the roof constructions and surrounding details of a building entirely independent of surrounding influences.

EXERCISE VI

26. This exercise will consist of seven problems laid out on five sheets. Execute the following problems in perspective according to the instructions given. Each sheet will be $9'' \times 12''$ with border line $8'' \times 11''$. Draw a horizontal line $4\frac{3}{4}''$ above the lower border line to represent the horizon line, in each of the cases $11''$ long. The extreme ends of the horizon should be marked V^L and V^R and the center V^C .

PROBLEM 33. Exercise VI, Sheet I.—Take any point about $2\frac{1}{2}''$ below the horizon and $1''$ to the right of a perpendicular let fall from V^C as at a , and draw lines therefrom to V^L , V^R , and V^C . The lines from a to V^L and V^R will then form the sides of a rectangle, in perspective, and the line from a to V^C will form the diagonal of a square in perspective. At any convenient point, such as b , draw a line toward V^R intersecting the diagonal at c ; and through c from V^L draw cd . Then, with the **T** square, draw ce parallel to the horizon and draw ef toward V^L ; ce is the diagonal of

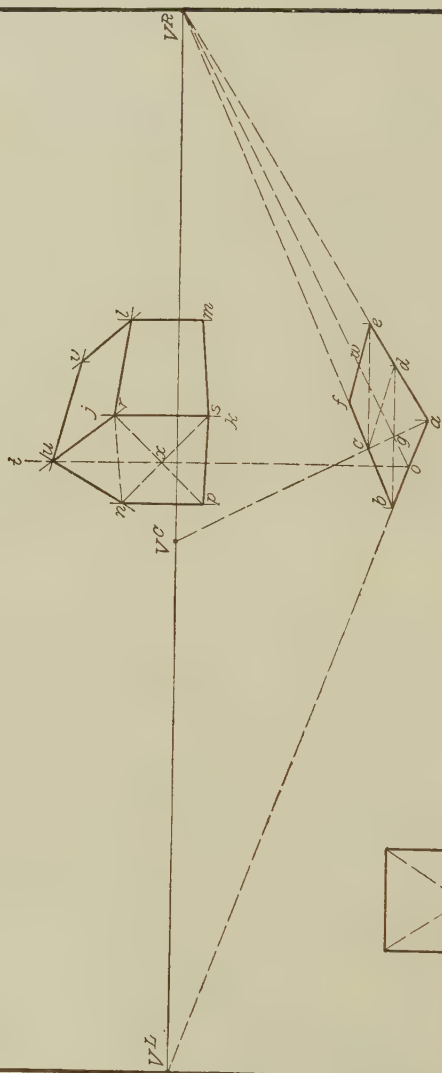


Fig. 11

an adjacent square. Draw the other diagonal of the first square bd intersecting ac at g , and draw the center line from g toward V^R and out to o . Directly above a and across the horizon draw the indefinite line jk , and similarly above e and b draw lm and np . Now, on jk , lay off the point r about $\frac{5}{8}$ above the horizon and s about $\frac{1}{4}''$ below the horizon, and from these points draw lines toward V^L until they intersect with the line np , and also from r and s toward V^R draw lines until they intersect with lm . Thus, we have a perspective view of a solid figure whose end $nrs p$ is a square and whose side $rlms$ is a rectangle consisting of two squares. The center of the end square is shown on the plan at o , and a line from o to t will establish the center line in the perspective elevation. From any point as u on ot above nr , draw lines to n and r , forming a gable, and the ridge may be drawn toward V^R , while the rear gable lv may be drawn by locating v directly over w and on the line from u to V^R . Or, to be exact, the point v may be established on the ridge of the roof tv over the point w in the plan where the ridge passes through the wall.

It is a demonstrated fact in geometrical drawing that the diagonals of any rectangle intersect each other at the center of that rectangle, Fig. 11, and therefore whenever in perspective drawing a rectangle in plan or elevation is met its center may be found by drawing diagonals. Therefore, on the end rectangle in this figure $nrs p$, diagonals may be drawn intersecting at x , and through x a perpendicular can be drawn to locate the point u as the ridge of the roof instead of projecting this point from the plan. The use of these diagonals should always be borne in mind in laying out any figure in perspective. Furthermore, any subdivision that can be performed geometrically in simple projection can be equally well performed in perspective projection and a full knowledge of this can be used to good advantage in all branches of perspective work.

If the side of a rectangle be divided, in any manner, near one end, equal subdivisions may be laid off near the other end by means of the diagonals.

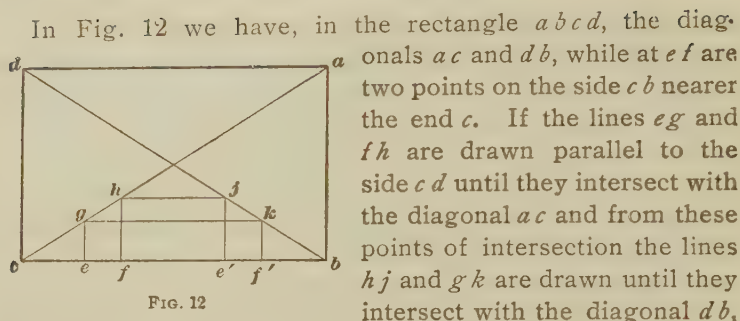
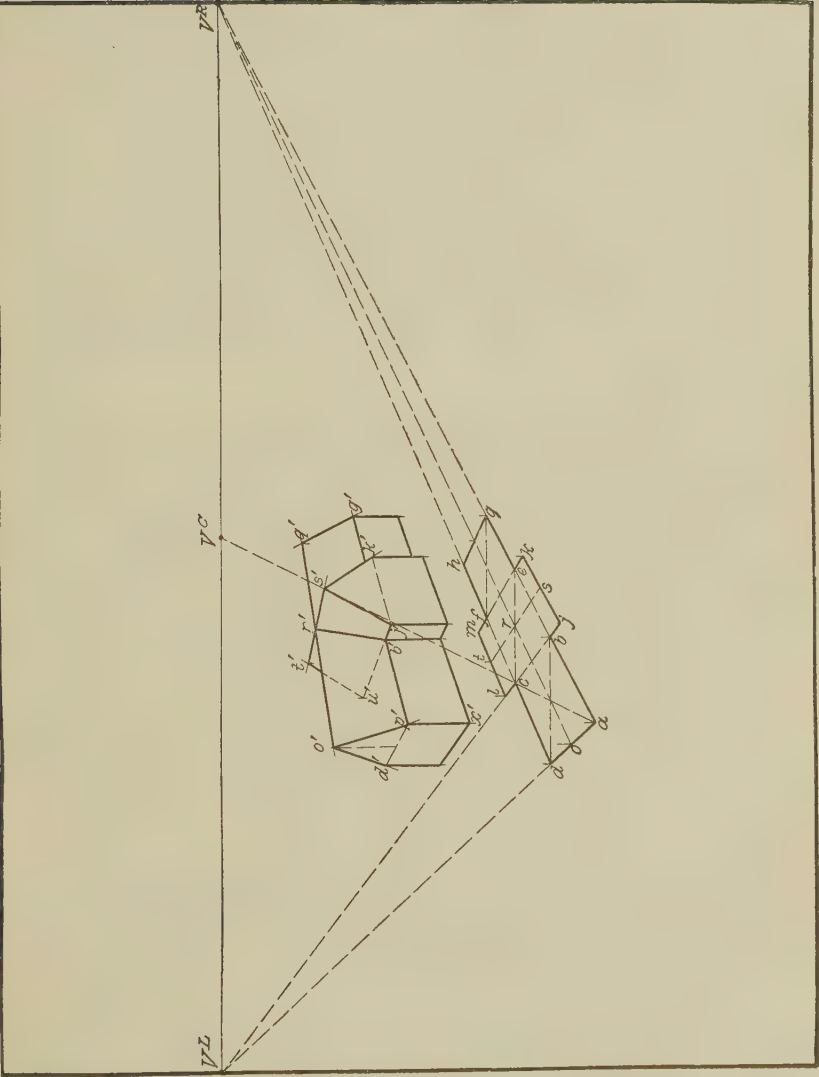


FIG. 12

lines drawn from the points j and k parallel to the side ab will intersect the line bc at e' and f' , so that the distances bf' and $e'f'$ will be equal to the distances ce and ef .

27. PROBLEM 34. Exercise VI, Sheet II.—To work this problem, lay out the horizon line and letter it as before; assume a point $3\frac{3}{4}''$ below the horizon and $2''$ to the left of a perpendicular dropped from V^C , and from it draw lines, as shown to V^L and V^R . Draw the diagonal ac from a toward V^C and construct a square similar to that in the previous figure by drawing a line from some point b to V^L until it intersects ac at c , and complete the square by means of a line from V^R through c to d . Draw ce and from V^L draw fe ; then draw fg and complete the third square $efgh$ by a line from g toward V^L intersecting dh at h . Continue the line cb somewhat beyond b , and draw jk ; and similarly beyond c draw lm . The distances from c to l and from b to j can be about $\frac{1}{8}''$ or $\frac{1}{4}''$. Draw the diagonal db , and where it intersects with the diagonal ac draw the center line that marks the end of the gable in plan at o ; also, draw from V^L a line through the point of intersection of ce with the ridge, and through this point draw st , the ridge of the wings of the house. Now construct entirely below the horizon a bird's-eye view showing this simple figure consisting of rectangular solids covered with intersecting prisms. For convenience, assume first the point p' about $1\frac{3}{4}''$ below the horizon and directly over a . Draw similar lines over d , b , j , k , and g . Now, from p' draw a line toward V^L until it intersects dd' ,



and also draw a line from p' toward V^R until it intersects $b b'$, and continue this line between the lines $k k'$ and $g g'$. From V^L draw $b' j'$. From V^R , through j' , draw a line until it intersects $k k'$. Draw $o o'$. From o' , draw a line to V^R until it intersects with $q q'$; then draw $q' g'$. Draw over r the construction line $r r'$, and through r' from V^L draw a line until it intersects $s s'$ and $t t'$. Draw $s' j'$ and $s' k'$. Draw, also, $t' u'$ showing the portion that extends beyond $o' q'$ as a dotted line. We have then the construction, in perspective, of two intersecting triangular prisms similar in form to the roof of a four-gabled house; and if from x' lines are drawn toward V^L and V^R to complete the ground line of the house as shown, the whole figure presents a bird's-eye view of the required solids.

28. PROBLEM 35. Exercise VI, Sheet II.—(Position of building changed.) For Problem 35 repeat the figure in Problem 34 in the same position relative to the two vanishing points, but with the horizon passing through it $\frac{1}{4}''$ above x' ; in other words, draw $x' p'$ so that it is about $\frac{5}{8}''$ in length and extends $\frac{3}{8}''$ above and $\frac{1}{4}''$ below the horizon. This will change the appearance of the roof materially, and the part $t' u'$ will disappear entirely behind $o' q'$ and the part $r' q'$ will partially disappear behind $r' s'$. The same plan can be used, and the instructions for drawing the perspective elevations can be followed letter for letter, care being exercised to see that the diagonals at intersections are constructed properly. Problem 3 can be executed on the same sheet as Problem 2.

29. PROBLEM 36. Exercise VI, Sheet III.—In Problem 36, the construction of the plan is entirely below the horizon and the elevation is entirely above. Draw the horizon $V^L V^R 3''$ above the lower border line. From V^C , draw a vertical line and $2''$ below the horizon locate the point a . Draw lines from a to V^L and V^R . Locate b about $1''$ from a and complete the perspective square by means of a line $b p$, drawn from b toward V^R , which intersects the diagonal from a to V^C at c , and a line from c to d from V^L through c . It will be observed here that the diagonal of the square is

perpendicular to the horizon in this particular instance. This is caused by the point a being exactly in front of the eye. ef is now drawn through c , and from e and f lines are drawn to V^L and V^R intersecting the diagonal at g . Now we have four squares in plan grouped so as to make one large square $afge$. The diagonal from e toward V^C intersecting dh at h gives us a fifth square when we draw the line hj . $2\frac{1}{2}''$ above the horizon locate the point a' . Draw $a'b'$ and $a'd'$, locating the points $a'b'$ and d' directly over a, b , and d of the plan. $1\frac{1}{4}''$ above a' locate the point k' directly over k in the plan, and draw $k'b'$ and $k'd'$. Then we have a square pyramid on the top of a square rectangular prism, or a similar problem to a square tower with a pyramid roof. Draw jj' and locate the point $j'1''$ above the horizon. From V^L draw a line through j' intersecting bb' . Locate $l'1\frac{1}{2}''$ above the horizon, and directly over l in the plan; draw from l' the ridge of the roof until it disappears behind bb' . Locate $l'1\frac{1}{8}''$ above the horizon, and $o'1\frac{3}{4}''$ above. Then complete the right wing as indicated in the illustration.

These exercises show the effect of drawing the perspective view above or below the horizon. The rendering of it in Problem 36 indicates a house as it would appear on a hill entirely above the eye, while in Problem 34 the drawing shows a building as it would appear in a bird's-eye view. The method of drawing is precisely the same in each case, and the position of the horizon alone is responsible for the two effects.

30. So far the reproduction of rectangular forms in perspective only have been considered. In Fig. 13 is shown, at $abcd$, a square surface in perspective, the sides ab and dc being parallel to the horizon; therefore the drawing is said to be in **parallel perspective**. The sides ac and bd vanish in the center at V^C , and the diagonals ad and bc vanish at V^R and V^L , respectively. If the side of the square ab is divided at points e and f so that the central portion ef will be equal to the side of an inscribed octagon, according to *Geometrical Drawing*, Problem 18, it is possible to draw fg

and eh to V^R and V^L , forming three sides of an octagon at $hefg$; and by locating the points k and l on the line cd by means of lines drawn from e and f to V^C , the lines lm and kn may be drawn through these points from V^L and V^R , respectively, thus presenting a complete octagon in perspective. By continuing the sides of the octagon he , fg , lm , kn until they intersect outside of the octagon, there is formed at o, p, q, r , another square whose sides or and op vanish toward V^L and V^R , respectively, and whose diagonal oq vanishes at V^C . This is the alternate of the previous square whose diagonals vanished at V^L and V^R , and whose sides vanished at V^C . It is evident that the two squares are identical in size, as they both circumscribe the same octagon and therefore $ofpg$ the side of one square is in reality the perspective equal of the side $ae fb$, which is in full scale. That is, if ab is $1\frac{3}{4}''$ long, op is $1\frac{3}{4}''$ long in perspective. By this means it is possible to draw to the same scale the perspective of a square or an octagon standing vertically, as shown in Fig. 14, or a cube, or an octagonal solid as shown in Fig. 15. Over the point o , Fig. 13, is drawn the line ab , Fig. 14, equal to ab , Fig. 13, and from a and b , Fig. 14, lines are drawn toward V^R . Over p , Fig. 13, a line cd is drawn forming at $abcd$, Fig. 14, a vertical square in perspective.

If on ab the points e and f are laid off so as to make the line $ae fb$, Fig. 14, equal in every respect to $ae fb$, Fig. 13, and from f and e , Fig. 14, lines are drawn toward V^R locating the points k and l , the sides of the inscribed octagon can be located by drawing vertical lines from f and g , Fig. 13, and connecting the points so located on points a and c and b and d with diagonals as shown. This is a matter of much importance, as the transition from the octagon to the circle consists simply in rounding the corners, as shown in Fig. 16 (a). Where the corners of the octagon abc , etc. are rounded off by tangent arcs so as to produce an ellipse, which represents the sides of the inscribed circle in perspective, and removing the circumscribed octagon, the perspective of a vertical circle is produced, as shown in Fig. 16 (b). The direction of the inclination of the ellipse at (a) and (b) varies because they are

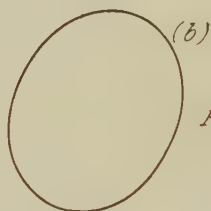
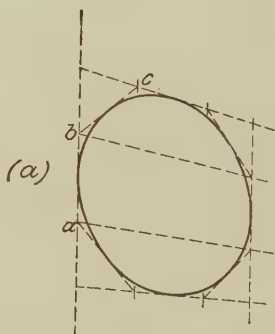


Fig. 16

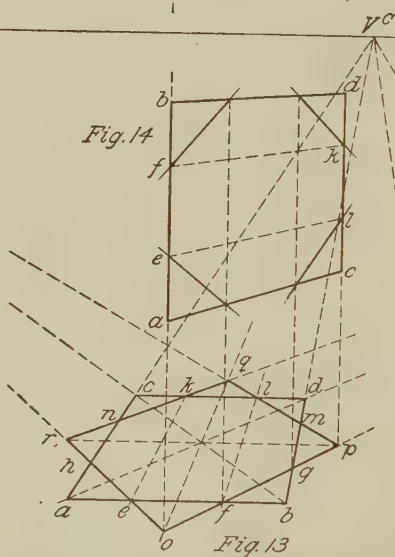


Fig. 14

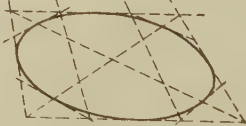
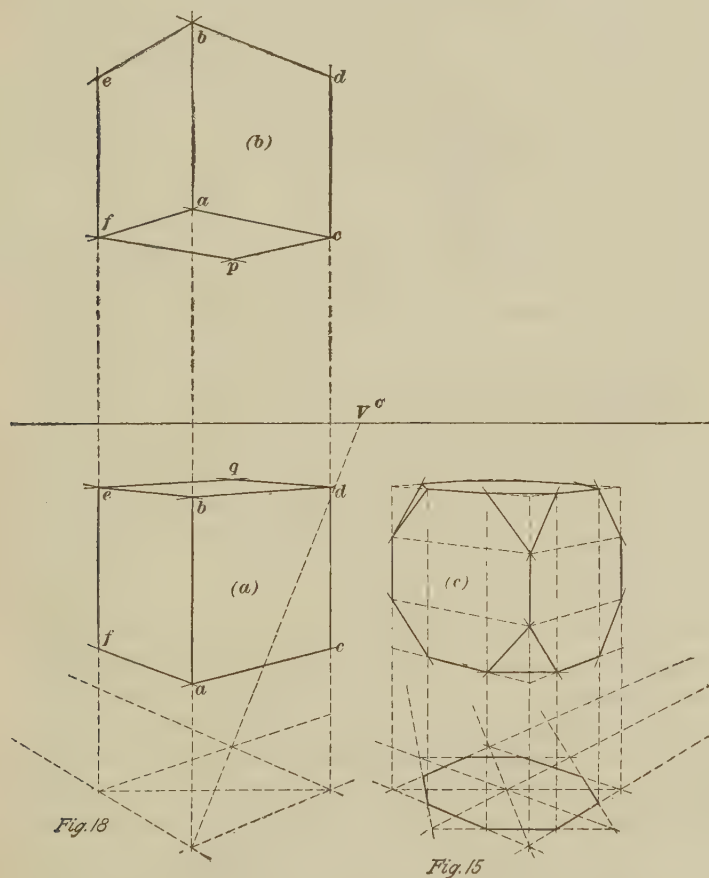


Fig. 17

on opposite sides of V^C . In a similar manner, the corners of a horizontal octagon similar to that shown in Fig. 13 may be rounded off so as to produce a horizontal circle in perspective, as shown in Fig 17.

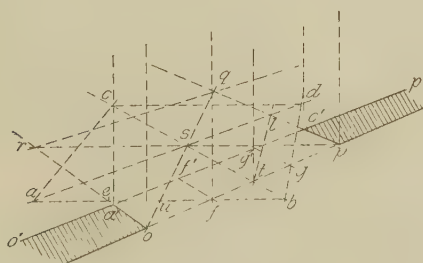
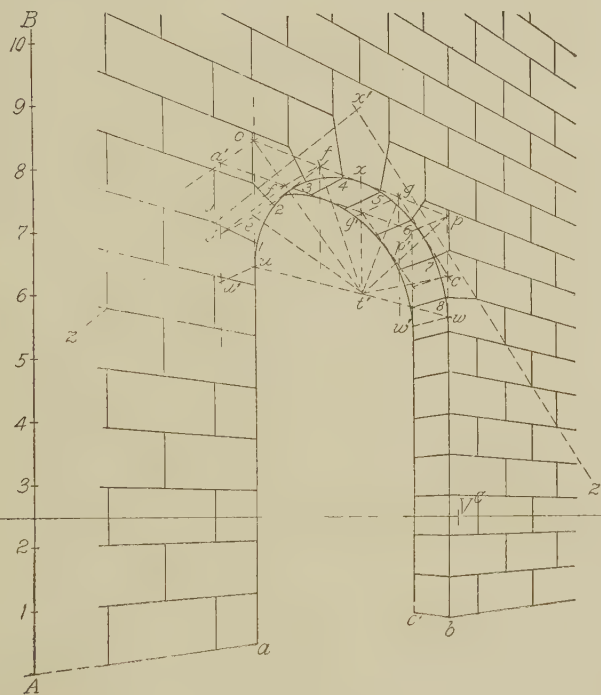
In a similar manner, lines drawn from a and b , Fig. 14,



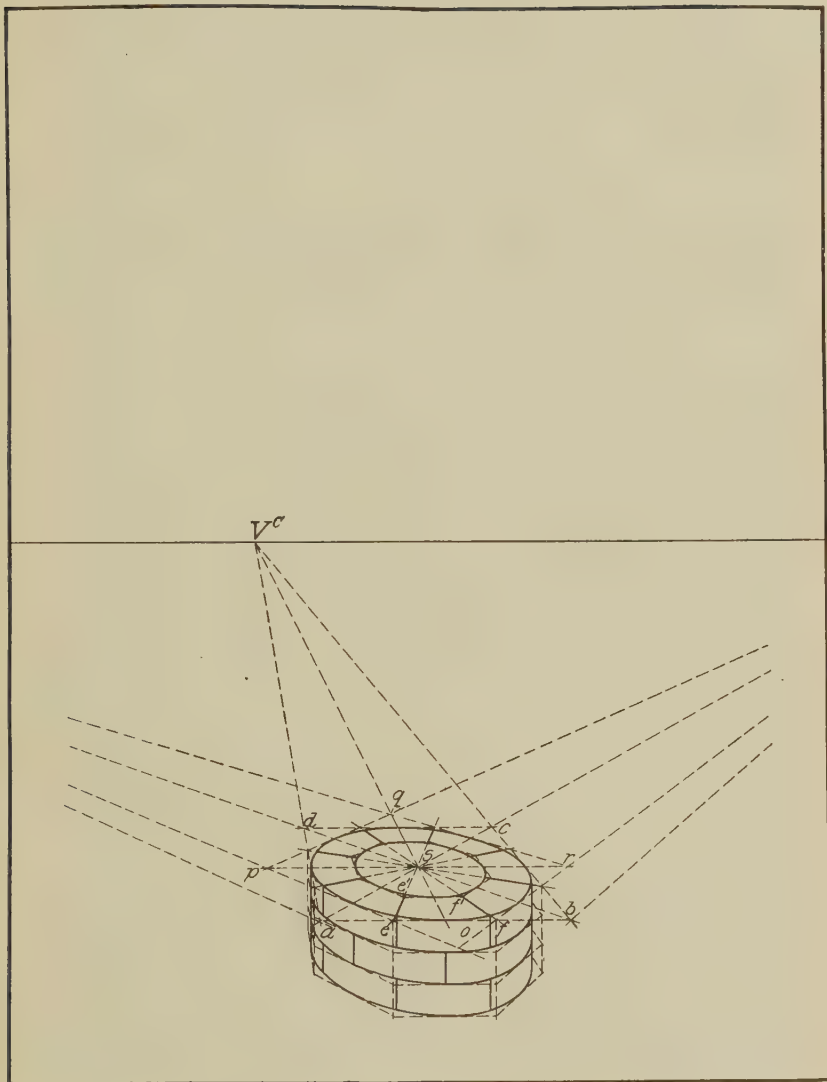
toward V^L form another vertical square in perspective, as shown at $abef$, Fig. 18, and lines from e toward V^R and from d toward V^L intersecting at q , Fig. 18, form at $bdqe$ another horizontal square in perspective, so that Fig. 18 now presents

the perspective drawing of a cube. The cube is converted into an octagonal solid by finding the inscribed octagon contained in its visible sides, Fig. 15.

31. PROBLEM 37. Exercise VI, Sheet IV.—The application of this system of vertical measurements is exemplified in Exercise VI, Sheet IV. Draw a horizon line 12'' long and locate V^C its center. This will necessitate the working of the problem on a larger sheet, but the drawing can be cut down when finished to the regular size. About 4'' below the horizon and $3\frac{1}{4}$ '' to the left of V^C locate the point a , and draw a horizontal line ab $2\frac{1}{2}$ '' long. From a draw lines toward V^C and V^R and from b to V^C and V^L ; these lines will intersect at c and d and the line cd can then be drawn, making a square $abcd$ in parallel perspective. On line ab lay off ae and fb equal to $\frac{2\frac{3}{8}}{3\frac{1}{2}}$ '', and ef equal to $1\frac{1}{16}$ '' and draw from e and f lines toward V^L and V^R until they intersect the horizontal line rp drawn through the point of intersection of the diagonals ad and bc . Through r and p , lines can then be drawn toward V^L and V^R , thus completing the square $opqr$ in 45° perspective. Draw the other diagonals sp and rt of the square formed at $tslp$, and through their point of intersection, draw $o'p'$ toward V^R and cross-hatch or color the portions beyond o and p , as shown; this will represent the perspective plan of a wall with an opening through it, the thickness of the wall being $\frac{1}{4}$ the width of the opening. Above o and p draw two vertical lines, the one through o extending below the horizon about $1\frac{1}{4}$ '' to a and above the horizon indefinitely; lay off on the lines over o , in the elevation, the distance ao equal to about two times the distance ab in the plan. Lay off ou and oe in the elevation equal to au and ae in the plan. The points f, g , and p in the elevation are directly over the points f, g , and p , in plan, and are on a line drawn from o toward V^R , while the point c is on a line drawn from c toward V^R . Thus, by drawing cf and gc , there is obtained $uefgcw$, a semi-octagon; and by rounding the corners a vertical semicircle in perspective uxw is formed. A line drawn from V^R through a in the elevation and from b



toward V^R , as shown, gives the perspective view of the outer surface of a vertical wall with an arched opening. The point c' in the elevation is directly over c' in the plan and on a line from b to V^L . The line $c'w'$ is vertical, and the point w' is on a line from w toward V^L . From o , in the elevation, draw a light line toward V^L and locate on this line the point a' directly over the point a' in plan. Draw from a' toward V^R a line until it intersects with $c'w'$ prolonged at p' , thus constructing the semi-rectangle $u'a'p'w'$. Draw, in the plan, $f'f'$ and $g'g'$ toward V^L and locate f' and g' in the elevation directly over these points. Draw in the elevation ee' . Construct within the semi-rectangle $u'a'p'w'$ a semi-octagon $u'e'f'g'$, etc., and within this octagon describe what is visible of the semicircular opening of the inside of the edge of the arch. It is of no importance whether or not the vertical line above a' in the plan passes through point c , or whether or not the line $e'f'$ in the elevation falls above the line ef , so long as the construction is accurate. Locate the center of the arch t' , which is directly over t in plan and is on a line from u toward V^R . Lines drawn from t' to e, f, g , and c , the angles of the circumscribed octagon, and other lines from t toward o, x , and p , which pass through the centers of the sides of the circumscribed octagon, will divide the semicircle uxw into eight equal parts. Subdividing these parts at 1, 2, 3, 4, 5, etc. gives division points of the **voussoirs**, as the wedge-shaped stones around the arch are called. Draw a line AB $1\frac{1}{8}''$ to the left of au , and lay off subdivisions on this line $A-1, 1-2, 2-3$, etc. $\frac{5}{8}''$ each. Draw lines from these points toward V^R until they intersect with au . Project them across the opening and from the line bw toward V^R ; draw the continuation of the joint lines. Locate x' $\frac{3}{4}''$ above x . Through the point where the joint line from t' to y intersects with the line from 8 to y , draw the line $x'z$. Where yz crosses the several horizontal joints marks the position for the vertical joints between the stones; these vertical joints are over each other in every other course. On the opposite side of the arch, another line $x'z$ may be similarly drawn and the joints on that side located also.



32. PROBLEM 38. Exercise VI, Sheet V.—Problem 38 is similar to Problem 37 except that the circle is rendered as a horizontal disk instead of vertical. Draw the horizon $V^L V^R$, as before, 12" long, locating the point V^C at its center. 4" below the horizon and $\frac{3}{4}$ " to the right of c locate the point a ; draw the line ab $2\frac{1}{2}$ " long. Construct the squares $abcd$ and $opqr$ precisely the same as in Sheet IV, thereby representing in perspective an octagon. Parallel to the side ef of this octagon draw $e'f'$ at any convenient distance, and then from $e'f'$ draw lines toward V^L and V^R until they intersect with the diagonals drawn from the center S to the angles of the octagon; thus a parallel interior octagon can be described as shown. Within these two octagons describe horizontal circles in perspective and emphasize the diagonals toward the angles of the octagons so as to represent joints in them. Below the square $abcd$ construct three or four similar squares about $\frac{1}{4}$ " apart; and within these describe similar octagons and circular arcs in perspective, thereby representing a well-curb or other circular-stone construction in perspective. Carefully ink in all the finished lines, but leave in pencil the construction lines here shown dotted.

PROBLEM 39. Exercise VI, Sheet V.—For Problem 39 make another drawing of the figure described in Problem 38, but place the line ab 3" *above* the horizon, and draw ad and bc down to V^C . The figure will thus appear as if viewed from below, similar to the view one would have of any object held above the level of the eye. Therefore, after the square $abcd$ is drawn in perspective *above* the horizon, the series of semi-ellipses will be constructed above the line ab instead of below it, as in Problem 38. Problem 39 can be executed on the same sheet as Problem 38. When these problems are completed and the proper lettering included (the title being PERSPECTIVE PROJECTION), each sheet should be cut to the exact size of 9" $\times$ 12", with border line 8" $\times$ 11" and then mailed to the Schools for correction.

FREEHAND AND ORNAMENTAL DRAWING

INTRODUCTION

1. Necessity for the Study of Freehand Drawing.

Some of the students taking up this Section have had, from a study of preliminary subjects, some training in mathematics, geometrical drawing, and projection drawing, to familiarize them with the making of certain calculations that may later be required, and to acquaint them with the use of drawing instruments and the typical geometric forms that are the basis of all drawing. Other students, however, are taking this Section as the first study of their Course. To both classes, therefore, it is proper to give some explanation as to the purpose of this Section, which may be considered as the first Section of the regular training in freehand drawing that this Course will give to them.

Not every student reading these pages has in mind the same ultimate goal. Some intend to be architectural draftsmen and architects, some have in mind the field of commercial illustrating, others are seeking to engage in some line of industrial designing, and still others aim to be trained as teachers of drawing. But to each and all of these a training in freehand drawing is of fundamental importance and absolutely necessary.

2. Fallacy of Idea of Natural Ability for Drawing.

The tendency of beginners in any line of art work is to

seek short cuts to proficiency. Just as the young student of music is eager to attempt to play composition pieces before learning the scales, so the beginner in art is prone to try to draw pictures, to design houses, book covers, wallpapers, etc., before having had his eye and his hand trained to draw even simple forms. The desire of students for such short cuts is frequently stimulated and encouraged by admiring friends, who have flattered them for their crude attempts at pictures and designs, or for their copies of the work of other artists. It is further stimulated by the incentives offered by irresponsible schools and personal art instructors, who tell these beginners that elementary study, in their case, is not required because of their unusual natural ability for drawing.

The sooner the beginner realizes that there are no short cuts and that there is no such thing as being born with an ability for drawing, the better he will be prepared to undertake a serious course of art training. One is no more born with an ability for drawing than he is born with an ability for story writing or for surgical work. It is true that one may have an inborn sense of beauty, of proportion, of humor, etc., and, through inheritance and early training, may have had his powers of observation, memory, judgment, imagination, etc., well developed. All these must be developed in the young artist who wants to be successful, but their development does not fall within the province of the art instructor. It is a common thing to hear the beginner in the study of commercial art say to his instructor: "I can copy pictures perfectly, but I cannot originate them; I want you to teach me originality." This shows an entirely wrong conception of the whole matter. These mental qualities must be acquired and developed by the student himself. No art instructor can give to the student originality, a sense of humor, keen powers of observation and memory, business enterprise, etc., and those who profess to do so are deceiving the beginner. But the duty of the art instructor is to train the student to DRAW; and beyond this he cannot honestly promise to go. (It is true he can, and should, advise the student on many features connected with the mental qualifications and busi-

ness requirements, this advice being based on personal experience.) By training a student to draw is not meant training him to copy the lines and pictures made by other artists; but it means training the student's eye to see accurately, and his hand to delineate properly what he sees, so that he may later make original compositions or designs.

3. Method of Teaching Freehand Drawing.—The student will find that his first exercise in this Section consists simply of drawing straight lines. To the beginner, eager to become a draftsman, an illustrator, or a designer, such simple exercises may be uninteresting, or even irksome, because he may think he is being delayed unnecessarily. If he will pause to consider that, before being able to do any drawing, his eye must be trained to judge distance and proportion accurately, and his hand trained to work easily and quickly and at the same time accurately, he will then see the necessity for such practice exercises.

To start the student at once in drawing difficult still-life objects, or even human figures in repose and in action, might appear, on first thought, to be the more direct and effective way of teaching him to draw. But it is reasonable to believe that he cannot draw complicated curves and planes, or portions of the human figure in their proper foreshortened positions—even though his eye may be skilful enough to *see* these proportions—until the muscles of his fingers, hand, and arm have been so trained that they are supple and act in quick response to the commands of the eye and the brain.

Drawing is *not* illustrating or designing; it is the means by which one expresses ideas of an architectural or decorative design, or of a picture, to some one else. In view of this, it might be thought that to teach comprehensively the drawing of any specialized line of commercial or industrial art work, we should at the same time teach all about its application; but experience has shown that such a procedure complicates the work of elementary instruction. It is best for beginners to learn first how to DRAW, and then later to learn how to make technical drawings.

4. Materials Required for Freehand Drawing.

Paper: Any good grade of white drawing paper, or "water-color" paper, that has a "toothed" (but not rough) surface, and is not glossy, will be suitable. The T. S. Co.'s C. P. White Drawing Paper gives good results.

Pencils: An HB and a 2H of the Aldebaran brand are needed. Other grades may be obtained as desired.

Drawing Board, T-Square, Triangles, Scale Rule, Drawing Instruments, Eraser, Thumb Tacks, etc.—the use of which is explained on pages 6 to 20 of Instruction Paper, Geometrical Drawing, to which the student should refer—are also needed. All these materials are included in the students' outfit which—if not already on hand—should be obtained at once.

5. Blocking-in the Drawing.—Blocking-in consists of the grouping of lines and masses according to the size



FIG. 1

or scale to which the drawing is made. Before beginning to draw a figure, its general effect and characteristic shape as a whole should be carefully observed. The individual form, the curves and scrolls, and the character of the foliage should then be studied; and its sym-

metry and the proportion of its parts, and the direction of its movement, should be borne in mind during the entire process of sketching it in. As to the size, it is sufficient to say that some definite scale of enlargement or reduction should be followed, so that everything can be maintained in equal relative proportion. In beginning to draw an object, first lay out the extreme outline, as in Fig. 1; then locate the principal points of extent and position by measuring from the base and center lines. The extreme outline should be composed of a few straight lines so arranged as to enclose the object in an irregular geometrical figure. The curves and

other details of the object may then be rounded in at the angles of the geometrical figure, as shown. For this measuring and locating, extreme exactitude is not required; there should, in fact, be as little mechanical measuring as possible, all minor details being gauged by the eye. Use the eye as much as possible, in order that it may become trained to judge correctly of absolute and relative sizes of form and proportion. The value of this accomplishment to the draftsman or illustrator cannot be overestimated. It holds within itself the entire principle of freehand drawing. Since the object is to learn to draw, and, in a measure, to obtain a knowledge of ornament, the points just given are of far greater importance than the mere act of repeating or copying lines. The purpose of this Course is not to make copyists, but to make draftsmen, illustrators, and designers.

The same spirit applies to the drawing of the two halves of any symmetrical ornament. Except in the main points of the form, no absolute identity of the two halves is to be attempted; there is no artistic necessity for such, either in drawings or in executed work. If some little inequalities appear in the two halves of some scroll or foliage work, leave them alone and remember that good ornament is enhanced in value, rather than depreciated, by the absence of constraint or of stiff regularity. The individuality of the designer, carver, or painter shows itself in such matters, and gives character to his work.

There is another very important point to be observed in the drawing of symmetrical figures. Never draw one half complete by itself and then the other half; lay the whole ornament out as one figure and finish it up simultaneously. Above all, never trace off one half of an ornament to produce the other half. This method of working is permissible in offices and shops, on the part of experienced draftsmen, and will be permitted in future work, but must be absolutely avoided by the student in the early part of his practice in freehand drawing. Remember that, in learning to draw, nothing will train either hand or eye so well as constant practice and redrawing of the same thing.

6. Drawing the Individual Lines.—In making both straight lines and curved lines, they must be drawn in even, regular strokes, not in a succession of short scratches. The strokes must be continuous, each being a continuation of the preceding one, and as long as one unconstrained movement of the finger joints will make them, which is about $\frac{3}{4}$ ". This is the best method to maintain the proper direction of the lines to be drawn, and to develop most readily the pliability of the hand and the judgment of the eye by fastening the attention and efforts of both on making a continuous line.

In drawing, the elbow may rest on the drawing board, but the ball of the hand should be as free as possible, in which position the hand will rest and travel along lightly on the first joint of the little finger.

The eye must guide the hand in drawing, but should not be riveted too closely on the pencil; a glance forwards and backwards over the work, to compare the form of the design and the direction of the lines, will enable you to keep your work close to the original, which is all that is at present desired.

In blocking-in the figures on the Exercise Sheets in this Section an HB pencil may be used; but, in drawing the individual lines of the figures, use a 2H pencil with a sharp point.

7. Object Drawing as Supplementary Practice.

The method of training the student in freehand drawing that will be followed in this Section has just been explained. This is what is known as *drawing from the flat*, and is the simplest possible method of teaching form and proportion, eye measurement, dexterity of fingers, etc., to students who take up these Courses. It must be well understood, however, that this Section is only a preliminary training for the more advanced freehand work that comes later. (For instance, the student of Illustrating will later take up the work of drawing from nature, drawing from casts, drawing from the human figure, etc.).

It would be of advantage to every student, however, to do as much additional practice work as possible, aside from the regular prescribed work of this Section. This supplementary practice work should consist of making pencil drawings, in outline, of simple objects that one sees every day. In doing this work the suggestions given below should be followed.

1. *Only objects of simple form should be selected.* Objects of every-day household or office use should be used as models. Among these may be cubical or oblong boxes, such as cigar boxes, shoe boxes, containers of foodstuffs, medicines, etc., to start with. Next, cylindrical objects, such as cans, jars, goblets, etc., may be attempted, fol-



FIG. 2

lowed by those of conical, spherical, and other shapes. Start with the simpler shapes and work progressively toward the more difficult ones.

2. *Method of placing the objects for sketching.* Place the object on a table of average height in such a manner that it is about on a level with the eye of one who is seated, as the goblet shown in Fig. 2 (a). If necessary, place a few books under the object so as to raise it to the desired height. Do not have the object below the level of the eye so that one looks down on it, as in Fig. 2 (b) and (c).

3. *Proper position when sketching the object.* The student should be seated in a chair in such relation to the table upon

which the object rests that the lower edge of the inclined drawing board rests on his knees and its back rests against the edge of the table. Sit upright when working, with the board about at arm's length; do not lean over the board.

4. *Manner of holding the pencil.* The pencil should be fairly soft, such as an HB, and should be held in quite a different manner from that described for drawing ornamental figures on a small scale. Let the pencil rest lightly on the balls of the four finger tips, these fingers being *underneath* the pencil and facing upward, the pencil being held lightly in place by gentle pressure from the ball of the thumb placed on the top of it. In this way the pencil will not be rigid in the hand (although it can be made so), but will have a certain freedom and flexibility that will greatly assist in securing a correct drawing. In this way the point of the pencil will be directed toward the top, or top left-hand corner, of the board.

5. *Method of sketching objects.* Practice making straight lines, first vertical, then horizontal, then oblique ones. After that, various curves should be attempted. If the fingers get tired or cramped, rest them. Let the arm swing free from the shoulder; do not rest the wrist or elbow on the board, merely steady the hand by resting the tips of the fingers against the paper.

Work entirely by eye measurement. The system of using the pencil held at arm's length between the eye and the object, vertically to measure vertical lines, and horizontally to measure horizontal lines, may be used. The dimensions projected on to the pencil may be marked by the thumb nail thereon, and transferred to the drawing. Draw boldly, but not hastily and carelessly. At first make the lines lightly and—if they are found to be wrong—do not erase them, but simply draw over them with heavier and more accurate lines. After each object is drawn, the drawing should be carefully compared with the contours of the object itself to see where errors have been made.

The student is NOT to send this supplementary practice work to the Schools. Only the regular Exercises are to be sent.

EXERCISES

NOTE.—All the drawings in this Section, including practice figures, border lines, lettering, etc., are to be drawn **IN PENCIL ONLY**. The use of ink is not required, for any purpose whatever, on any of the drawing sheets in the subject of Freehand and Ornamental Drawing.

8. There are in this Section six required drawing exercises, each consisting of four sheets. Each sheet, when trimmed to proper size, should be $9'' \times 12''$ with a border line $8'' \times 11''$. Each sheet of drawing paper that comes to the student from the dealers is usually $15'' \times 20''$, thus enabling the student to get therefrom *two* drawing sheets each $9'' \times 12''$. The extra margin around each $9'' \times 12''$ sheet need not be considered wasted, for it is useful for trying the pencil, holding the thumbtacks, etc.

All the required figures on the students' drawing sheets are to be executed entirely *freehand*, and all measurements laid off by the judgment of the eye, except in such cases where the student is told he may use instruments. Before attempting to draw any of the figures, the text directions must first be carefully read and understood.

Before making the final drawings that are to be sent to the Schools as exercises for correction, the student must do a great deal of practice work on each figure.

In preparing the drawing sheets, the directions should be followed exactly as given in the following pages. When the set of sheets for Exercise I has been completed, these sheets should be carefully rolled and placed in the cardboard tube, and mailed to the Schools for examination. While we are examining your Exercise I you may be working on the drawings for Exercise II, but do not send these to us until your Exercise I has been returned to you.



Fig. 1



Fig. 2

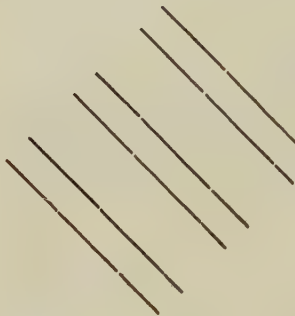


Fig. 3

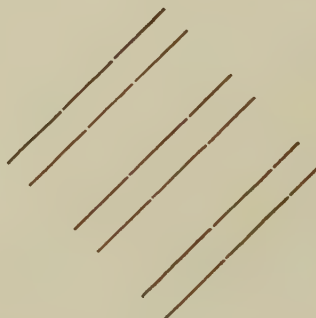


Fig. 4

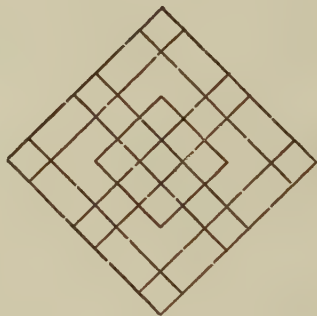


Fig. 5



Fig. 6

EXERCISE 1, TITLE: LINEAR ELEMENTS

9. This exercise consists of four sheets each of which you should be able to execute perfectly without other aid than the directions herewith given. The succeeding exercises will each contain some detail or element, the instruction for which can be traced to this exercise. It is absolutely necessary, therefore, that the student should be perfect in every detail of each exercise before attempting the next one. The figures on this exercise are simple lines and combinations of lines to produce some of the elementary forms that enter largely into all classes of design. Drawing these trains the eye and hand to work together, and thereby become sufficiently practiced to execute the problems that follow. The drawing of a single line is of as much importance as the execution of an entire design, and each simple problem should be practiced constantly and patiently before the next is attempted. If each lesson is thoroughly learned, the next one will invariably prove easier.

Please note carefully that you are NOT to send us any of the small figured *text* illustrations. The exercise sheets you will prepare for us are shown in the *full-page* illustrations, enclosed in border lines, on pages 10, 21, 26, and 29.

10. In Fig. 1 of Sheet I is shown the method of drawing perpendicular straight lines. The pencil should be held lightly between the thumb and forefinger, with its upper end resting against the forefinger between the second and the third joints, while the end of the middle finger rests on top of the pencil alongside of the forefinger.

If, however, a fixed habit of holding the pencil in some other manner has already been acquired, it will probably be found simpler to continue in that way.

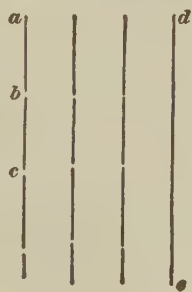


FIG. 8

The drawing board should be squarely in front and the elbow should rest near the bottom of the board, somewhat

to the right of the drawing on which the student is at work. A short straight line is then drawn, as from *a* to *b* in Fig. 3, and the arm shifted a little lower down on the board, and

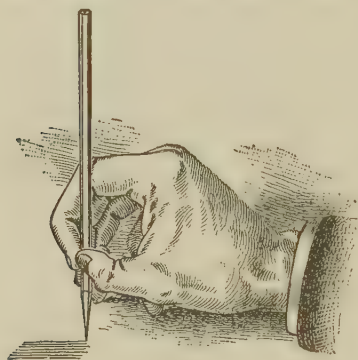


FIG. 4

another line, as *bc*, drawn, care being taken that there is a space of at least $\frac{1}{2}$ " between the end of the line *ab* and the beginning of the line *bc*. A third section of the line is then drawn from *c* downwards, and so on, until the line is of the desired length, which is about $2\frac{1}{2}$ ". Each section of the line is about $\frac{3}{4}$ " in length, as that is about as long as the average

person can draw it with one unconstrained movement of the fingers. When the pencil is drawn down as far as the fingers will conveniently act, the hand becomes cramped as shown in Fig. 4 and it should then be shifted and a new section of the line started. Having practiced this several times, gradually decrease the spaces between the sections of the line until it appears as a straight unbroken line, as shown at *de*. It is necessary to be still more careful in doing this, lest the lines overlay one another or curl out at the ends. The former error causes the finished line to appear somewhat as in Fig. 5 (*a*); while the line composed of strokes whose extremities are curled will appear ragged, as in Fig. 5 (*b*). The strokes with which these lines are made are not short quick dashes of the pencil or pen, but slow even marks, each of which is started carefully, drawn slowly, and finished abruptly, so as to show a clean, even



FIG. 5

stroke, the same weight throughout, perfectly black, and clean cut from end to end. The second stroke must never lap over the first, and it is better to let a hairbreadth space remain

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between the ends of the lines than to have the least suggestion of a line like Fig. 5 (a). Practice this simple line exercise repeatedly, as in it lies the whole key to successful freehand drawing. When proficiency in this has been acquired, commence work on the drawing sheets to be sent to the Schools.

11. Exercise I, Sheet I.—First draw the limiting outline of the edge of the sheet $9'' \times 12''$. Then $\frac{1}{2}''$ inside these lines, all around the four sides, draw the border lines, which will enclose a space $8'' \times 11''$, as explained for laying out the exercises in *Geometrical Drawing*. Draw a line horizontally through the $11''$ length of space within the border line and midway between the top and bottom border lines. This will divide the sheet into two horizontal bands. Divide the length of one of these bands into three equal parts, and through the points of division draw light vertical lines, thus converting the surface of the drawing into six rectangles. This may all be done with the T square and triangle; but, from this point on, all work must be done freehand. Each figure must be drawn as nearly as possible in the center, between the vertical lines of its respective rectangle. Each figure of the upper row should be drawn $\frac{3}{4}''$ above the lower horizontal line of its rectangle, the bottom of the figures of the lower row being about $\frac{3}{4}''$ above the lower border line. Now draw the first figure of this exercise; this consists of seven perpendicular lines, each of which is approximately $2\frac{1}{2}''$ long and spaced as shown, and about $\frac{3}{8}''$ or $\frac{3}{4}''$ from its neighbor. Only one of them need be an absolutely solid line, the others being composed of dashes about $\frac{3}{4}''$ in length.

The drawing of horizontal lines should be practiced in a similar manner, except that the elbow should be drawn nearer the body. When the strokes forming the horizontal lines are drawn, the whole arm should be moved toward the right, in order to prevent the lines from becoming arched, as will be the case if the elbow remains fixed and the hand are moved only so far as the swing of the arm will permit. The strokes forming the horizontal lines may be somewhat longer

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than those composing the vertical lines, but the method of forming one straight line, by the careful union of several smaller ones, remains precisely the same for both cases.

In drawing the horizontal lines, see that perfect parallelism is maintained; the spacing between the lines, however, may be gradually increased or decreased in order to better train the eye as well as control the hand. In drawing Fig. 2 of the exercise, make the upper and lower three lines $\frac{3}{8}$ " apart, and $\frac{3}{4}$ " from the middle line, all the lines being about $2\frac{1}{2}$ " long. The lengths of these lines and their distances apart *are to be judged by eye measurement only*, which can readily be done after repeated practice on separate sheets of paper, the practice lines being frequently tested with a scale rule. No scale rule, however, is to be used when the figures on the drawing sheet are drawn.

12. Figs. 3 and 4 show two sets of parallel oblique lines, the former being drawn from right to left, and generally called *right-oblique* lines, and the latter drawn from left to right, and usually designated as *left-oblique* lines. Fig. 3 is much the easier to draw, as the slope of the lines corresponds in direction to the inclination of the letters in ordinary handwriting, and the hand is more accustomed to the angle. After practicing the right-oblique lines until assured that they can be drawn as well as the two previous sets, draw a series in the direction shown in Fig. 4 of Sheet I. To do this it will be necessary to change the position of the arm, so as to bring the elbow toward the right end of the board and the hand above, and to the right of the lines to be drawn. The lines in Figs. 3 and 4 should incline at an angle of 45° , and should be arranged in pairs, as shown, with $\frac{3}{8}$ " between the individual lines of each pair, and a distance of about $2\frac{1}{4}$ " between the extreme outside lines of each figure, the lines each being about 2" long, all these dimensions and angles being judged by eye measurement alone.

13. Figs. 5 and 6 involve no new principle in drawing and are simply a combination of the preceding problems. Observe, however, that though these two figures contain

exactly the same number of lines and nearly the same lengths of lines, they are, in appearance, entirely different. This difference of appearance is due to the composition of the figures; many changes of arrangement can be effected without altering the number or size of the lines. In line composition, the designer has but two elements to consider—the lines and the spaces. He may darken some of the spaces, thereby entering into surface composition, wherein he has at least two more elements to consider—*light* and *shade*. Fig. 6 of the text shows six problems in composition,

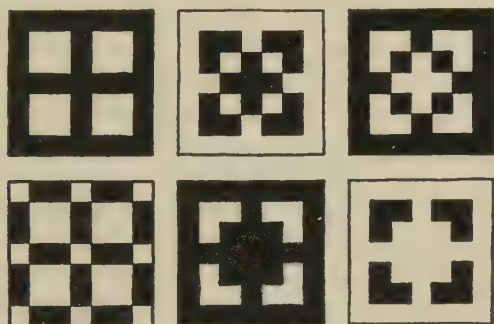


FIG. 6

all based on the line elements as arranged in Fig. 6 of the exercise, but treated differently as to light and shade, thus illustrating the fact that even with a few elements of composition a great variety of design may be produced. The blackening, or shading, of certain parts of a line composition, in this manner, is technically termed *spotting*, and when a plain line drawing is thus treated it is said to be *spotted*. None of the figures in this exercise are to be spotted; they are to be left entirely in outline.

To draw Fig. 5, erect a perpendicular in the center of the rectangle, and draw right and left oblique lines, each at an angle of 45° , and $2\frac{1}{2}''$ in length. These oblique lines should be drawn purely by eye measurement. It will defeat our purpose in training you to do freehand work, if you use any instruments or mechanical aids. Let these two lines be the lower sides of a square standing on its corner. Having

completed the square draw $\frac{3}{8}$ " within each of its sides, a line parallel to that side, and through the center of the square draw parallel lines $\frac{3}{8}$ " apart, as shown. The small inscribed square may then be drawn, each side of which is 1".

The square enclosing Fig. 6 is $2\frac{1}{4}$ " on each side. The lines of its composition are variously spaced from $\frac{1}{8}$ " to $\frac{3}{8}$ " from the left side and top, respectively. The same number of lines and nearly the same lengths of lines are used in both Fig. 5 and Fig. 6, but, as said before, the student can readily see the variation of effect that may be obtained by the simple arrangement of a few lines.

The exact sizes and dimensions of the several interior squares are not matters of importance to us now, and the student's drawing of this figure will be judged by the care of his execution rather than by the accuracy of eye measurement.

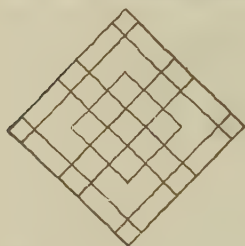


FIG. 7

The angles of the square must be 90° , not more nor less, and opposite sides must be perfectly parallel, while adjacent sides must be perpendicular to each other. The straightness of the lines or their exact length as to this description will not be considered.

For instance, a drawing like Fig. 7 of the text will be considered as satis-

factory at this stage of the work, for, though the lines are somewhat irregular, their directions are correct and they intersect at right angles; and though the inner rectangles are larger than the corner ones, they are perfect squares and are all the same size. They thus preserve harmony in the figure and avoid the appearance of irregularity and carelessness shown in Fig. 8 of the text, wherein the lines themselves are more nearly perfect, but their direction and parallelism extremely faulty. Draw Figs. 5 and 6 several times on a separate piece of paper before executing them on the drawing sheet.

These simple line exercises are of the utmost importance, as on them will depend much of the future freehand work. Practice each set repeatedly on a sheet of ordinary detail

drawing paper, until able to produce, at will, perpendicular, horizontal, or oblique lines and then, but not until then, attempt to draw them on the sheet that will be sent to the Schools for correction. Each of these exercises should be drawn as carefully and as accurately as though it were a part of a complicated design. Haste will only produce slovenliness and impede the progress toward becoming a good draftsman. *Neatness, accuracy, and rapidity* are the three qualifications of a good draftsman, in the order of their importance, and the last is of no value unless accompanied by the other two, while the second is impossible without the first. After completing the figures and border line on Sheet I, carefully letter the title of the exercise, **LINEAR ELEMENTS**, in the center with the larger vertical lettering shown in Fig. 9, the exercise number on the left and sheet number on the right, above the upper order line, as in *Geometrical Drawing*; and the time consumed, date, name, class letter and number below the lower border line, in the smaller lettering on the 60° slant.

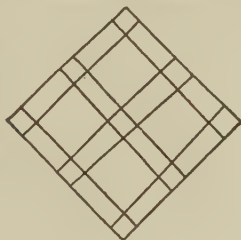


FIG. 8

LETTERING ALPHABET

14. In lettering the titles in this and subsequent Sections, the alphabet shown in Fig. 9 of the text should be used. This is based practically on the same lines as the geometrical alphabet given in *Geometrical Drawing*, except that the details are changed in order to be better suited to freehand work. While there is no objection to the pencil outlining of this alphabet with the T square and triangles, the finished work should be drawn freehand; and in doing this it should be borne in mind that the duplication, line for line, of the letters shown in Fig. 9 is not what is required, but an intelligent use of this form adapted as it is to single-stroke work. With a pointed soft pencil, such as an H, an HB, or a B, the vertical and horizontal lines of this

A B C D E F G

H I J K L M N O

P Q R S T U V

W X Y Z

a b c d e f g h i j k l

m n o p q r s t u v

w x y z

1 2 3 4 5 6 7 8 9 0

alphabet can be executed in two strokes placed side by side so close together that they form one in general appearance. The spurs at the ends of the strokes can be put on afterwards with a finer point, or they may be indicated simply as straight lines, and the top and bottom pieces indicated with the soft pencil in a single stroke, the angle afterwards being rounded off. If these letters are executed with a single stroke of the pencil, it will make the governing lines somewhat lighter, but there is no objection to this if the student finds it easier.

Good lettering is an essential requirement for all good draftsmen, but by good lettering is not meant perfect lettering. The uniformity of line composing the letters, and the evenness of spacing due to the intelligent placing of one letter next to another, and a proper proportioning of different sizes of letters in a title are the elements that constitute good lettering rather than the forms of the letters themselves. Some draftsmen will make the cross-line of the A particularly high; others will make it very low. There is no objection to either practice. The fact that the cross-line of the B, E, F, and H must always be above the center does not follow that it must be close to the center, and many draftsmen will exaggerate the position in these letters and make it unusually high, all of which is permissible. The vertical lines of the H, M, and N are frequently inclined so that the letter is much narrower at the top than at the bottom, and the two middle strokes of the M are frequently depressed much less than is shown in this example. Therefore, the student need not feel, in lettering his drawings, that he is to copy any particular outline. If in his endeavor to use originality he commits any serious error, it is easily corrected when his exercises are criticized, and he should devote his entire efforts to making pleasing letters rather than perfect ones.

The size of the letter is also of comparatively slight importance as long as it is large enough to suit the drawing on which it is placed. The examples here are shown $\frac{3}{8}$ " for the capital letters, and $\frac{1}{4}$ " for the body and smaller letters.

20 FREEHAND AND ORNAMENTAL DRAWING §3

If the sizes are reduced one-half, no harm is done so long as the letters are good. Generally speaking, in practicing letters it is best to keep them fairly large in the beginning, as large letters are more easily spaced than small ones. Give particular attention to the following details:

In all letters where there is a single vertical line, be sure that this line does not incline to the right or to the left; and, in letters where there are two vertical lines, if one is inclined, the other must be inclined at the same angle. Horizontal lines at the tops and bottoms of letters must always be perfectly horizontal. But horizontal lines in the middle of letters may be altered to incline upwards toward the right. In making the letters C, O, and Q, a top-heavy appearance is avoided by making them slightly oval with the small end upwards. With slight practice, you should be able to make this alphabet directly with the pencil and not be compelled to block in the letters first.

For lettering the exercise number and sheet number above the upper border line, and the name, class letters and number, time consumed on sheet, and date, below the lower border line, the small lettering inclined at the 60° angle should be used, the letters being $\frac{3}{8}$ " high, as on the *Geometrical Drawing* exercises, or $\frac{1}{8}$ " high, just as the student prefers.

15. Exercise I, Sheet II, includes Figs. 7 to 12 and is drawn on a sheet $9'' \times 12''$, with a border line $8'' \times 11''$. The sheet is turned with the $11''$ dimension as the height, and a vertical line drawn down the center, and two horizontal lines through the $8''$ width, thus dividing the sheet into six equal rectangles. Each figure is then spaced in its appropriate rectangles, as before.

16. Fig. 7 is an equilateral triangle, the base of which is $3''$ long. The inclination of the sides is not so easy to judge by the eye as were the 45° lines in Figs. 3, 4, and 5, but by remembering that the apex must be exactly over the center of the base, little trouble will be experienced. After the triangle is drawn, bisect the sides and draw the enclosed triangle as shown.

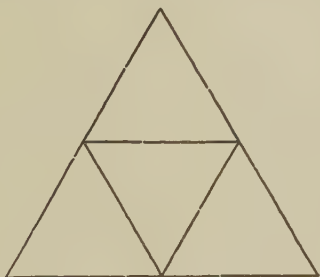


Fig. 7

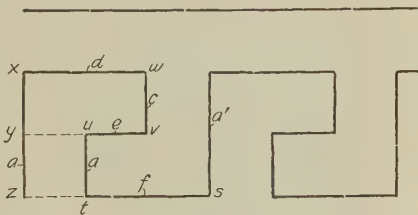


Fig. 8

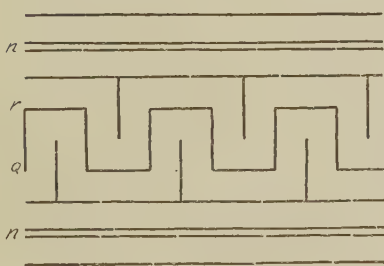


Fig. 9

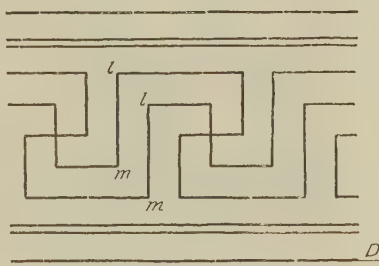


Fig. 10

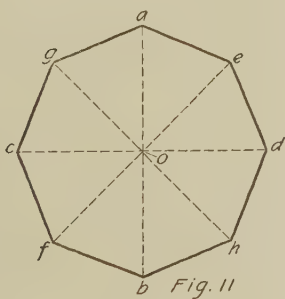


Fig. 11

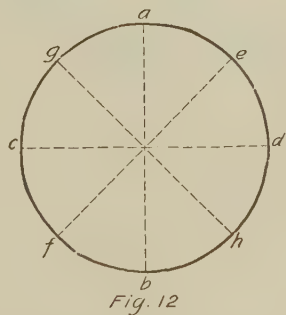


Fig. 12

Figs. 8, 9, and 10 are examples of borders taken from Greek pottery, and are composed entirely of straight lines, that when spotted as explained in connection with Figs. 6 and 7 of the text, can be made interesting and complicated. For instance, on looking at Fig. 10 of the text we observe that the pattern consists of two outline forms identical in every respect, and so shaped that one fits exactly into the other; that the lines *a* are all of the same length and at right angles to each other and the lines *b* are all twice the length of lines *a*.

17. For Figs. 8, 9, and 10, draw with the T square three horizontal lines at *x*, *y*, and *z*, about $\frac{5}{8}$ " apart. Fig 8 is then executed by drawing a freehand vertical line *xz* across the three lines thus ruled; and at a distance to the right of this vertical, equal to the space between the horizontals, another

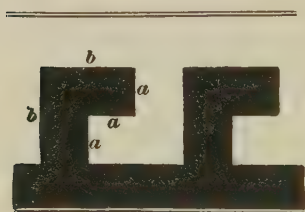


FIG. 10

vertical line *ut* is drawn between the two lower horizontals. A third vertical line *wv* is then drawn the same distance to the right of the second one, and extending between the upper two lines. The horizontal lines *xw* and *uv* are then drawn, connecting the ends of *xz* and *wv*,

and *wv* and *ut*, as shown, and with *ts* equal to *xw* the outline of one of the sections of the fret is complete. The vertical line *a'*, drawn to the right of *wv*, will then start a second section of the fret, and at the same time, complete the inverted outline that is to follow the contour of the first section. A peculiarity of all the best Greek frets is that the outline of the fret and the outline of the background are identical, as shown in Fig. 10 of the text. Having drawn the meandering outline of the fret, draw the horizontal border lines above and below, so as to make the whole figure $2\frac{1}{2}$ " high. It is not necessary to erase the construction lines.

18. Fig. 9 is somewhat similar to Fig. 8, but is capable of more variations in spotting, as shown in Fig. 11 of the text. At (*a*) we have the ground and the pattern of the fret

spotted in contrasting colors, while the effect at (c) is produced simply by increasing the weight of the constructive lines. Both systems produce frets wherein the ground and pattern are similar in outline. At (b), the line of separation between the dark and light portions of the design is thickened into a white band and the other elements are left in black. To draw Fig. 9, a number of perpendicular lines are drawn across the center line y equal in length and spacing to the distance between the three horizontal guide lines x , y , and z . The tops r and bottoms q of each alternate pair of the verticals are then connected with a horizontal line equal to the verticals. This forms the meandering outline of the figure. Above and below this meandering outline, at a distance equal to half the space between the lines, two horizontal lines are drawn, from which perpendiculars extend into the open parts of the meander as far as the middle horizontal guide line y . The border lines above and below are then drawn to make the entire figure $2\frac{1}{2}$ " high.

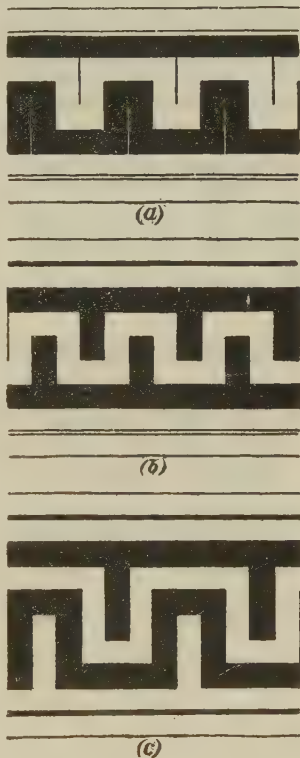
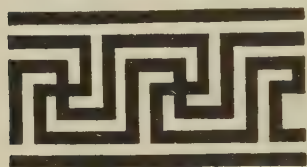


FIG. 11

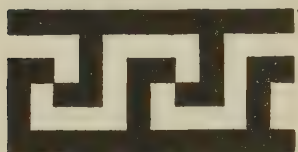
19. Fig. 10 is more complicated. It is a combination of Figs. 8 and 9, and when analyzed shows two distinct but identical outlines so interwoven as to form one harmonious design. This design may be made very complicated by spotting, as shown in Fig. 12 of the text. None of the frets on the exercise sheets are to be spotted; they are to be left in outline.

To draw Fig. 10 of the exercise, the simplest method is to draw across the central guide line a short vertical line

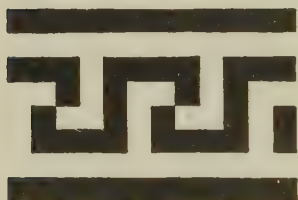
equal in length to the verticals in Fig. 9; then, through the center of this vertical, draw a horizontal line of the same length, thus forming a simple cross, ab , cd , Fig. 13 (a).



(a)



(b)



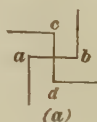
(c)

FIG. 12

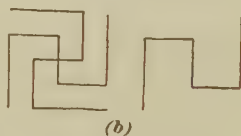
one section, and the same operation may be repeated, making the intersections of the short cross-lines take place at a point five times the space between the horizontal lines to the right.

20. Fig. 11 is a simple octagon, but to draw it accurately requires more care and accuracy of eye measurement than any of the previous figures. Begin it by drawing a perpendicular line ab , about $2\frac{1}{2}''$ in length. Carefully lay off the length of cd , $1\frac{1}{4}''$ each side of ab ; ef and gh are now drawn at an angle of 45° with ab , and intersecting it at its center o . From o , carefully lay off $1\frac{1}{4}''$ on each

Now, from the upper and lower ends of the verticals, draw lines of equal length to the left and right, respectively, and from the left and right of the horizontal line draw at right angles a line extending below and one above the center guide line and equal in length to the other lines drawn; this will produce a figure similar to Fig. 13 (a). Now draw a third set of lines at right angles to this second set and parallel to the first set, as shown in Fig. 13 (b). These lines are the same distance apart, and are exactly parallel. The horizontal lines at the top and bottom may now be extended to left and right, respectively, a distance equal to the space between parallel lines of the meander; this will complete



(a)



(b)

FIG. 13

of the oblique lines, as its length each side of the center. If this work is accurately done, the lines connecting ae , ec , ch , etc. will describe a perfect octagon. Study it carefully, and if any signs of unevenness are observed, alter the outline and correct the point.

21. Fig. 12 is a circle, but it is drawn in precisely the same manner as the previous figure, except that the points ae , ed , etc. are connected with curved lines instead of straight ones. In drawing the circumference of the circle, after the guide lines have been carefully laid out, a short straight line may be drawn across the ends of each of the guide lines, as shown in Fig. 14 of the text at a ; then between each pair of these short lines another short line may be drawn, producing a sixteen-sided polygon; the whole circumference may then be evened up as at b . Considerable practice is necessary to draw a perfect circle, but one will be surprised and delighted to learn how simple a problem this is after careful and repeated practice. After completing the figures, border line, etc., the title LINEAR ELEMENTS, exercise number, sheet number, date, name, class letters and number, etc. should be lettered in their appropriate places, as explained for Sheet I.

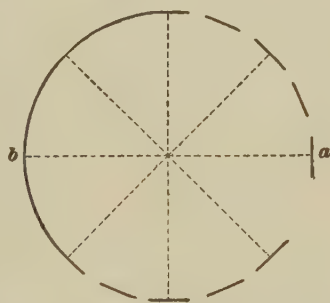


FIG. 14

22. Exercise I, Sheet III, includes Figs. 13 to 17. A horizontal line should be drawn $4\frac{5}{8}''$ above the lower border line dividing the plate into two horizontal bands. Bisect the upper one, and trisect the lower one; thus making five rectangles on the plate, in each of which its appropriate figure will be placed. Figs. 13, 14, and 15 are ellipses. The three large ellipses in these figures are each $4\frac{1}{4}''$ long and $2\frac{1}{2}''$ wide and the fourth one, intersecting the large one in Fig. 15, is $4''$ long and $1''$ wide.

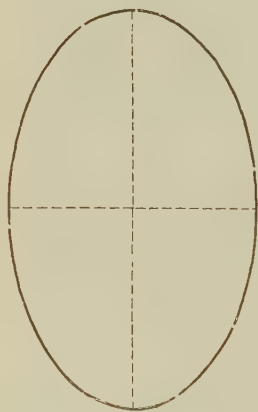


Fig. 13

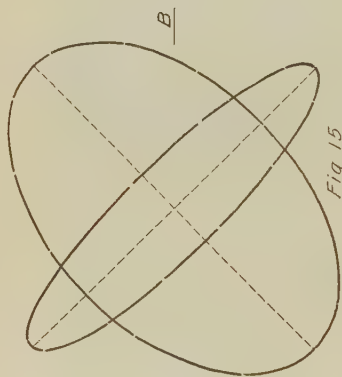


Fig. 15

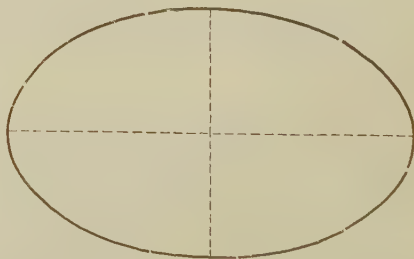


Fig. 14

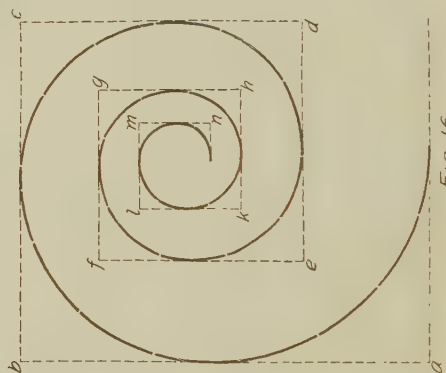


Fig. 16

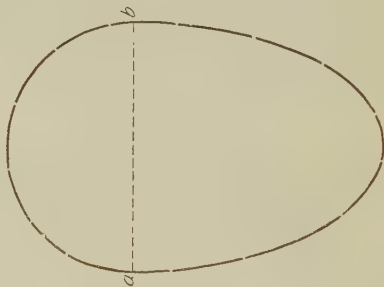


Fig. 17

The method of drawing an ellipse geometrically was explained in *Geometrical Drawing*, so that the characteristics of the curve should be known by this time. First draw the two axes, then draw short straight lines at right angles to the ends of the axes, and roughly sketch in the curve, in pencil, as shown in Fig. 15 of the text. Care must be exercised, however, to keep the proper curvature and avoid such sketches as those shown in Fig. 16 of the text. It is easily

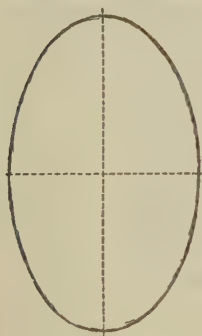


FIG. 15

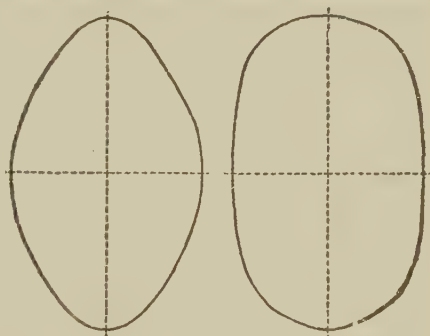


FIG. 16

seen that these are not ellipses, and drawing sheets must not be returned with any such monstrosities. This is a difficult figure to draw, but with proper care and practice it can soon be satisfactorily rendered. The construction lines of Figs. 11 to 15 should be drawn freehand.

23. Fig. 16 is a volute more commonly known as a spiral, and its outline in varied forms pervades all styles of ornament; it is therefore worthy of considerable attention. The example here given is purely Greek in its proportions, and the ratio of its height to its width is governed by definite geometrical rules for each convolution or turn.

To draw the Grecian volute, the construction lines ab , bc , and cd must first be laid out in the proportions shown, and succeeding construction lines in the same proportions. These proportions of the lines are those that have been accepted by students of classic architectural orders as governing the most graceful Grecian volutes.

The actual dimensions of the various construction lines should be laid out as follows: $ab = 4''$, $bc = 3\frac{3}{8}''$, $cd = 2\frac{3}{4}''$, $de = 2\frac{3}{8}''$, $ef = 2''$, $fg = 1\frac{1}{16}''$, $gh = 1\frac{3}{8}''$, $hk = 1\frac{3}{16}''$, $kl = 1''$, $lm = \frac{3}{2}''$, and $mn = \frac{1}{16}''$.

Within these construction lines (which must be accurately laid off with the scale, and drawn with the T square and triangle), the volute is then drawn freehand, care being exercised that the curves are just tangent to the straight lines as they pass. To prevent the curves from being flat, or from being sharp and oval shaped, where they touch the construction lines, draw them from the inside, using the wrist as a pivot, and turning the paper whenever necessary. Such a method will give the most graceful curves.

24. Fig. 17 is an oval and is composed of a semicircle and a semiellipse. Draw freehand the line ab $2\frac{1}{2}''$ in length. Above this line construct a semicircle in the same manner as was done in Fig. 12, using ab as its horizontal diameter, and below construct a semiellipse after the manner practiced in Figs. 13, 14, and 15, with ab as the minor axis, which shall extend $2\frac{1}{2}''$ below ab . The correct outlining of these elliptic curves is of vast importance in the exercises that follow, and should be frequently practiced. After finishing the sheet, insert the title LINEAR ELEMENTS and other lettered details in the customary places.

25. Exercise I, Sheet IV, is laid out on a sheet $9'' \times 12''$, with border line $8'' \times 11''$. By a vertical center line and a horizontal center line, the plate is divided into four equal rectangles, which are occupied by Figs. 18 to 21, inclusive.

Fig. 18, though simple in appearance, is by no means easy to draw. It represents the radiation of lines from a point, a characteristic of the growth of some plants that is frequently taken advantage of in examples of ornamental design. To draw Fig. 18, first lay off the lines ab and cd as the major and minor axes of an ellipse identical with Fig. 14; then carefully outline this ellipse in pencil, and within it draw the radiating lines curved, as shown. Note

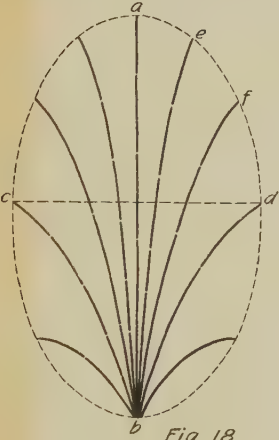


Fig. 18

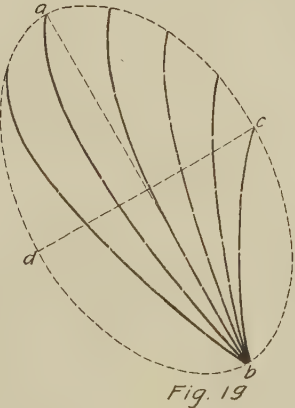


Fig. 19

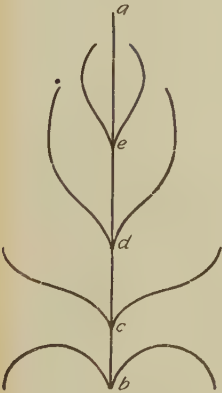


Fig. 20

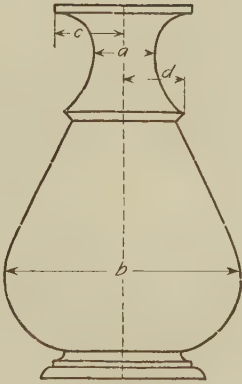


Fig. 21

that the radiating lines intersect the circumference of the ellipse nearer together at the top than at the sides, ae being less than ef and ef less than fd . After completing the figure, the construction line cd should be erased, and the ellipse dotted in with the pencil and irregular curve.

26. Fig. 19 is drawn within an ellipse also, but the major axis ab is inclined at an angle of 60° . The curved lines radiate evenly from b and intersect the circumference in three points equally spaced between a and c . In finishing this figure, all construction lines should be erased except the elliptic curve from c to a , which may be dotted in with the pencil and irregular curve.

27. Fig. 20 is another example of radiation, but from a line in this case instead of a point. Draw ab 4" long, and mark off thereon the points from which the curved lines radiate. Note that these points are not regularly spaced along ab , but that their distance apart increases toward the top. From b to c is about $\frac{5}{8}"$, while the distances cd and de are nearly 1" each. The radials starting from c extend $1\frac{1}{8}"$ to the right and left of ab , and upwards to the level of d . The radials from d extend $\frac{5}{8}"$ to the right and left of ab , and those from e only $\frac{3}{8}"$. Their length and upward extent must be judged by the eye, as also the two lower radials, which extend about 1" each side of ab .



FIG. 17

These radiating figures must be studied carefully; there is really very much more in them than at first appears, and the principles of their composition and construction pervade all natural ornament.

The radiation of the lines in Figs. 18 and 19 is characteristic of the growth of some plants, such as the cattail, as shown in Fig. 17 of the text, and the veining of certain leaves, as in Fig. 18 of the text. The radiation from a line, as shown in Fig. 20 of the exercise, is characteristic of the growth of

many trees and shrubs, and illustrates the great laws of all foliated ornament. These laws are based on the observation of the arrangement and natural growth of plants, and are as follows:

1. *All lines should radiate from a parent stem.*

2. *All branching lines should be tangent to the line from which they branch,* as in Fig. 20, where the branching lines do not start out of *ab* abruptly, but are tangent to it at *c, d*, etc.

3. *There should be a proportionate distribution of areas.* This is not so easy to understand as the previous rules, but may be illustrated by a tree, wherein the areas are proportioned according to their distribution and distance from the parent stem. The trunk is the parent stem, and has the greatest area, but decreases toward the top. The branches nearest the ground are the largest and closest together, and diminish in size toward their ends. All branches and twigs are less in area than the branch from which they spring. In Fig. 20 observe that, though the parent stem and branches are single lines of equal thickness and apparent area, the arrangement is such as to give the impression of distribution. The area embraced by the lower branches is greater than that of the ones above, and the outline of the entire figure diminishes toward the top, giving an impression of lightness and solidity.

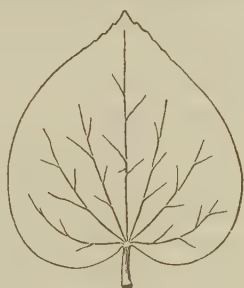


FIG. 18

Always observe these rules in drawing any figure, and try to make the representation of an object appear lighter toward the top. Note that in all works of architecture, high structures, such as steeples and towers, are either made smaller toward the top, or are pierced above with large windows in order to give the appearance of lightness at the top and solidity at the bottom. Note that columns, pilasters, and piers are nearly always smaller at the top than at the bottom, thus expressing their immovability; while the legs of tables and other unfixed objects are smaller at the bottom than at the top, expressive of their movability.

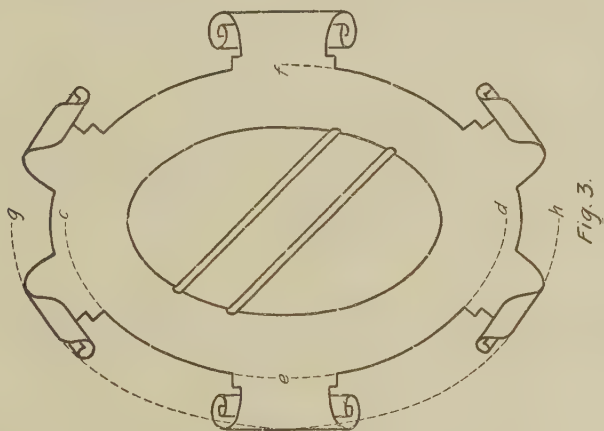
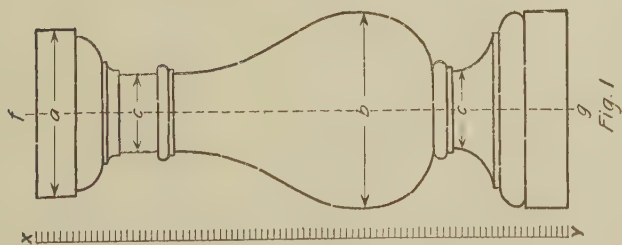
28. In drawing Fig. 21, simply combine the details of a few of the previous problems. This figure is a vase 4" in height, and $\frac{5}{8}$ " and $2\frac{1}{2}$ " in diameter at *a* and *b*, respectively. Draw the center line of the vase and lay out the outline entirely freehand and by eye measurement. Knowing the dimensions *a* and *b*, the observing student will discover that *c* is a little more than *a*, and that *d* is a little less. Other dimensions can be judged by comparison in the same manner and the figure completed without further directions. Letter the title **LINEAR ELEMENTS** at the top of the sheet, and place the other lettering at the proper places.

All the drawings should then be looked over carefully and compared with the full-page illustrations on pages 10, 21, 26, and 29, to see whether the student has done his best in drawing the figures, both as to actual proportions and as to neatness of execution. If there are any figures or parts of figures that the student believes he can improve upon, corrections and improvements should be made before sending the work to us. We do not want students' practice work on these exercises; we want their final very best work—work that is done to the best of their ability after practicing faithfully.

The four sheets of Exercise I, **LINEAR ELEMENTS**, should then be placed flat in the large envelope, stiffened with the cardboard, and mailed at first-class postal rates to the Schools for examination. This work will be returned as promptly as possible; and for this reason the student should not be unduly impatient about getting it back. He should concentrate his attention in making a start on Exercise II, title: **Surfaces and Solids**.

EXERCISE II, TITLE: SURFACES AND SOLIDS

29. The figures of Exercise II consist of a series of objects, the drawing of which will involve all the principles learned in the execution of Exercise I. The first four figures are designs of surface ornament or details wherein the consideration of depth or thickness forms no part. The remaining



figures will be sketches of familiar objects drawn so as to accustom the student to the representation of objects where the dimension of thickness or depth must be expressed in elevation or perspective.

Exercise II will consist of four sheets, outside measurement $9'' \times 12''$, and $8'' \times 11''$ within the border, as before. The first three sheets will consist of Figs. 1 to 7, but on the fourth sheet the option is given the student of working out the iron-strap work on Sheet IV (*a*), the iron knocker and lantern on Sheet IV (*b*), or the lamps and basket on Sheet IV (*c*). This variety is given that the one may be drawn that is most suitable to the taste. There is no objection to the drawing of more than one of these three sheets if it is desired, and in the correction of the work, it may be required that some of the other figures be drawn if the sheet selected is not worthy of a passing mark. It is always better to do too much free-hand drawing than too little, as subsequent work will require a considerable knowledge of freehand handling, and the more practice one gets in this branch the better.

30. Exercise II, Sheet I.—The center line of Fig. 1 will be $2\frac{1}{8}''$ to the right of the left-hand border, and that of Fig. 2 will be $1\frac{3}{4}''$ to the left of the right-hand border. Fig. 3 will then be drawn midway between.

Fig. 1 is a baluster with moldings, according to the architectural proportions set forth for such details. First lay off with the scale rule a vertical measuring line xy , $\frac{1}{2}''$ to the right of the left border. This line will be divided into eighty-eight equal parts, as shown, each of which is $\frac{1}{88}''$, making the height of the baluster $5\frac{1}{2}''$. All the measurements for the proportioning of the baluster will be given in parts, each part being, as above stated, $\frac{1}{88}$ of the total height. The width of the abacus *a* is twenty-eight parts, the thickest part of the baluster at *b* is thirty-two parts, and the diameter of the neck at *c* is twelve parts. The vertical measurements can be determined by counting the number of parts between each division, and when all the horizontal lines are located the contour may be carefully sketched in. Although these

proportions are subject to slight relative alterations under different circumstances, they are practically uniform in nearly all cases where the outlines of a stone baluster are required.

31. Fig. 2 is a panel of an iron railing, the design of which consists of a series of scrolls and radiating ornament, based on the outline of the baluster just drawn, but changed to suit the circumstances required by working in strap iron, in contrast to the requirements of stone. Attention is called particularly to the fact that there is propriety in the ironwork design in making its outline resemble the outline of the solid baluster, inasmuch as it is to serve a similar purpose in a balustrade of different material. The contour of the inside ironwork follows as closely as possible the contour of the stone baluster.

32. Fig. 3 is a design for another device in ironwork, but one of an entirely different character, being a cartouch made of sheet iron, the design of which is based on the ellipse.

Cartouch is the term applied to circular, oval, or shield-shaped devices, whose surface is represented in relief, and the border of which is usually more or less ornate with scrolls or strap work. In order to understand the character of Fig. 3, study Fig. 19 of the text,

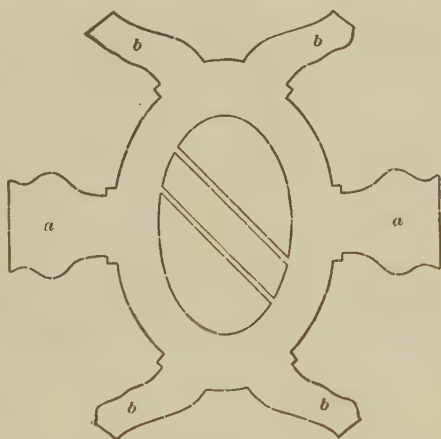


FIG. 19

which is a developed outline of the piece of sheet iron or other metal from which the cartouch would be made. The wings *a* are rolled backwards and the wings *b* rolled forwards, and produce the effect expressed in Fig. 3 of the drawing plate. Lay out the figure first, as shown in the text, and cut it out of heavy paper or thin metal; then by rolling the wings

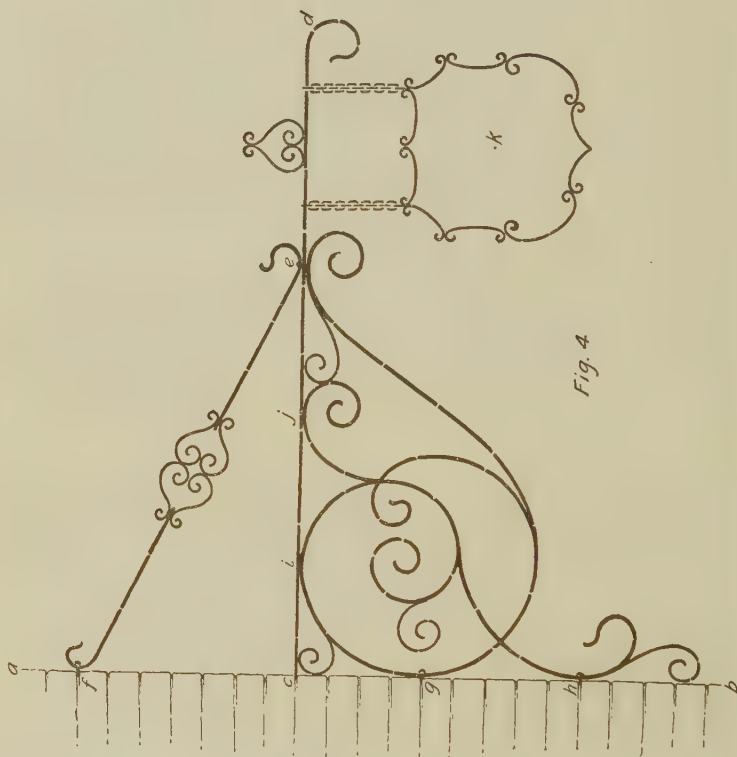


Fig. 4

around a pencil in the direction indicated, form a model of the device; when set up before you, this will greatly assist in the representation on the exercise. The length of the ellipse from *c* to *d* is $4\frac{1}{2}''$, while its breadth from *e* to *f* is $3\frac{1}{4}''$. The interior ellipse is $3\frac{1}{4}'' \times 2''$, the circumference of which is practically parallel with the outside. After the wings have been rolled over, they project uniformly from the top and sides of the cartouch, so as to come within the outline of another ellipse shown dotted at *g h*. There is nothing difficult in the drawing of this figure, the ellipses being contoured in the same manner as in Exercise I, Sheet III, and the curled wings being represented by a simple combination of scrolls and straight lines. It is not necessary to erase the guide lines.

Cartouches are not only executed in metal work, but are often carved in stone or wood, or modeled in plaster or terra cotta. They are also sometimes drawn, as in this exercise, as an ornament at the top, or in the center, of some certificate, or other paper of a documentary character. Its purpose, in nearly all cases, whether carved in stone or wood, or drawn or printed on paper, is to bear a device—either a number, a title, or a monogram. There are many forms of it, some being regular, as in this case, and others being irregular and eccentric, according to the purpose for which it is required.

It is not necessary to erase construction lines. Draw the border line and carefully letter the title SURFACES AND SOLIDS, and the other required lettering, in the accustomed places.

33. Exercise II, Sheet II.—In Fig. 4, which occupies the whole sheet, we have an iron bracket, such as is used in many cities as a sign hanger. It consists of straight and curved iron rods bent into scrolls, combining beauty of curve with utility of purpose. The main rod of the bracket *cd* is $6\frac{3}{4}''$ long. At *e*, $4\frac{1}{4}''$ from *c*, a hanger extends to the main wall at *f*, $2\frac{1}{4}''$ above *c*, while from the same point *e* on the under side of the rod *cd* the main scroll springs and becomes

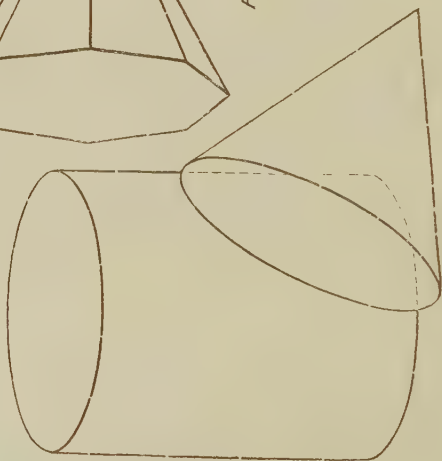


Fig. 5

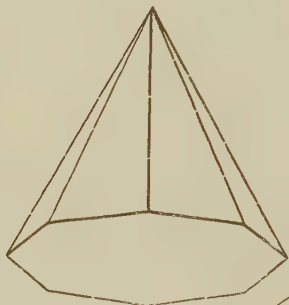


Fig. 6

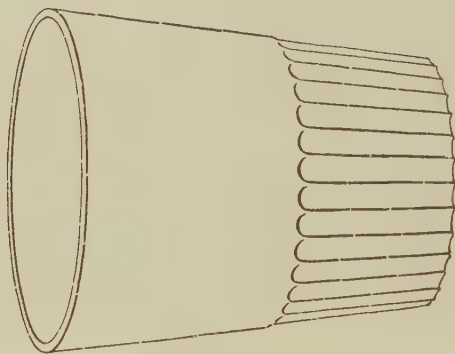
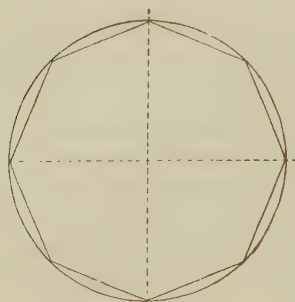


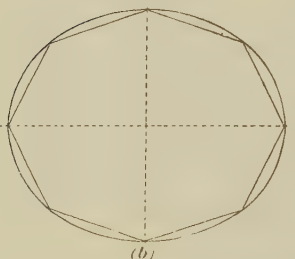
Fig. 7

tangent to the wall at g , $1\frac{3}{8}''$ below c . The branch scroll is tangent to the wall at h , $3''$ below c , and the other tangent points at i and j , $1\frac{1}{4}''$ and $2\frac{3}{4}''$ to the right of c , respectively. The other curves of the scroll, and the small ornamental scrolls on the top and sides of the main bar and hanger, can be proportioned and drawn by the eye, altering and shifting them as the circumstances may dictate. The sign itself (not including the chains) hangs below the bar within a rectangle $2''$ square, the center of which is at h , $5\frac{1}{2}''$ to the right of the wall and $2''$ below the bar cd . The rectangle containing the sign should be drawn in place and the sign sketched within it. After the figure is drawn all the guide lines may be erased. Take plenty of time and pains in drawing this figure, as its style is not only useful for many devices and designs, but the same design will be used later to illustrate an advanced branch of ornamental iron work. Draw the border line and letter the sheet as usual.

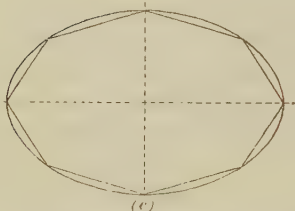
34. Exercise II, Sheet III, includes Figs. 5, 6, and 7, which are sketches of objects in perspective. While it is not the intention in this Section to teach the theory of perspective drawing, there are a few simple details concerning perspective representation that are not only useful, but in some instances of design positively necessary. In the first place, the appearance of a circle in perspective is always elliptic, and when one draws an ellipse, either mechanically or freehand, he represents thereby the perspective view of a circle. Practice frequently the drawing of ellipses of different sizes, and particularly of different widths on the minor axis; for instance, start, say, with a circle $3''$ in diameter and then draw an ellipse $3'' \times 2\frac{1}{2}''$ and another $3'' \times 2''$, thus decreasing the length of the minor axis and maintaining the same length of major axis until this diminishing circle reaches the limit in a straight line. Having done this, draw inside of the circle some polygon, as shown in Fig. 20 (a) of the text, either an octagon or a hexagon, or even a triangle, and then project horizontally across from the circle, through all the ellipses, lines marking the corners of the



(a)



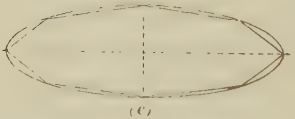
(b)



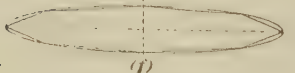
(c)



(d)



(e)



(f)

FIG. 20

polygon where they intersect the circumference of the circle. Short straight lines, connecting successively these points in the circumferences of the ellipses, will give a perspective view of the polygon inscribed in the circle, as shown at (b), (c), etc.

35. Fig. 5 of this exercise is a perspective view of a cylinder and a cone, the former standing on its base and the latter lying on its side. The top of the cylinder is an ellipse $3'' \times 1''$, and the bottom is a semiellipse of the same size. The height of the cylinder is $3\frac{1}{4}''$, and straight lines connecting the extreme outside points of the ellipse and the semiellipse complete the drawing of the cylinder and represent it as it would appear in perspective. To execute the perspective view of the cone, locate a point $1\frac{3}{8}''$ below the right-hand end of the longitudinal axis of the ellipse forming the top of the cylinder. Locate another point $\frac{1}{4}''$ below the base of the cylinder and $\frac{1}{4}''$ to the right of its axis. Connect these two points with a straight line. On this line, an ellipse $3''$ long by $1''$ wide is then drawn, similar to the ellipse forming the top of the cylinder. From the center of this ellipse draw a line $2\frac{1}{2}''$ long perpendicular to its major axis, and consider this line as the

axis of the cone. From the right-hand end of this line draw two lines tangent to the curve of the last ellipse, as shown, these lines forming the sides of the cone. This will complete the view of the cylinder and cone in perspective, and the portion of the cylinder that extends behind the cone, which is shown dotted in the drawing, should then be erased.

36. Fig. 6 represents an octagonal pyramid. The base of the pyramid shows an octagon in perspective, which is drawn within an ellipse 3" high by 1" wide. Perpendicular to the major axis of this ellipse a line is drawn $2\frac{1}{2}$ " long, which is the axis of the pyramid, and from the right-hand end of this line, straight lines are drawn connecting the corners of the octagon with the apex of the pyramid, thus representing that figure in perspective.

37. Fig. 7 is a perspective view of an ordinary tumbler, which, though slightly more complicated, and thereby demanding greater care in execution, is no more difficult to draw than either of the previous figures. The top of the tumbler is an ellipse $3\frac{1}{2}$ " long by 1" wide, and the bottom is one-half of a regular thirty-sided polygon drawn within an ellipse $2\frac{1}{2}$ " long by $\frac{3}{4}$ " wide. The distance between the major axes of the two ellipses is 4", and the sides of the tumbler are drawn tangent to the extreme ends of the curves. Above the bottom of the tumbler, about $1\frac{1}{2}$ ", a third ellipse is drawn lightly, to indicate the point where the fluting starts. Within the two lower ellipses two semipolygons are drawn in perspective, each with fifteen sides. These semipolygons should first be laid out in a semicircle above and below the major axes of the two lower ellipses, as shown in Fig. 21 of the text, and the points of intersection of their sides with the semicircle projected to

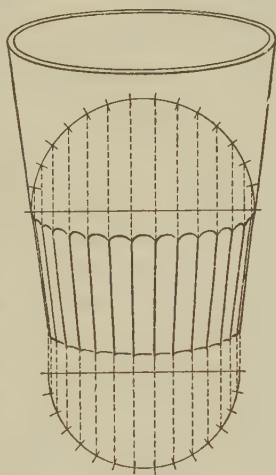


FIG. 21

the ellipses of the tumbler, in order to locate the points to draw the polygon in perspective. The subdivisions of the semi-circumference may be laid off by setting the legs of the dividers at a distance approximately correct, and then "walking" them along the circumference. It will be observed that this figure is simply a combination of the essential points of the two previous problems. This sheet should be finished and properly lettered, as were the previous sheets.

38. Exercise II, Sheet IV (a), consists of four figures all suggestive of elements of ornamental strap ironwork. Fig. 8 is a horizontal grille or border and should be constructed within a rectangle $1\frac{5}{8}'' \times 10''$, the top of the rectangle being $\frac{5}{8}''$ below the top border line. To draw Fig. 8, the rectangle should be carefully laid out, and the first scroll from the left end carefully sketched in. The points where this scroll becomes tangent to the top and bottom lines of the rectangle should be on the same vertical. From this lower point of tangency draw, with the 30° triangle, a diagonal line upwards and to the right through the figure, marking the upper point of tangency of the second scroll; another diagonal, at 30° , downwards and to the right from this last point will mark the tangent point of the third scroll; etc. With these lines as guides to the construction, carefully sketch in the main wave line of the scroll throughout the length of the rectangle. Carefully complete the scroll that forms the left end of the panel and with a soft sharp pencil trace it on a piece of tracing paper or cloth. Then turn over the tracing and after adjusting it in position for the second scroll go over the lines with a hard pencil as they show through the tracing and thus transfer the design to the second place. Repeat this operation for the third and fourth scrolls and then carefully finish the figure with a 2 H or a 3 H pencil.

Figs. 9, 10, and 11 are drawn in rectangles $4\frac{1}{2}''$ high; Fig. 9 is $4''$ wide and Figs. 10 and 11 are each $2\frac{5}{8}''$ wide. Each of these figures represents the same design¹ in iron grille-work. Fig. 9 shows the pattern as a flat surface in

Fig. 9

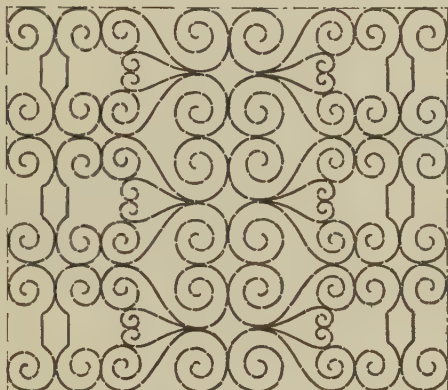


Fig. 10



Fig. 11



Fig. 8



three vertical panels; Fig. 10 shows it as it would appear if bent around three sides of a hexagonal prism with each side corresponding to one panel of the grille; and Fig. 11 shows it as it would appear bent into a semicylinder. Draw the three rectangles according to the above dimensions and then divide Fig. 9 into three equal vertical panels. Draw a horizontal line through the center of all three panels, and another horizontal line $1\frac{1}{4}$ " above and below the center line. Sketch in one of the scrolls in Fig. 9, then trace it on paper, and reverse the paper so as to transfer it in some other place. Repeat this operation until the design is complete. Carefully strengthen the design with a sharp pencil and complete the figure as shown.

Fig. 10 is also divided into three parts but these parts are not equal. On the bottom line of Fig. 10, describe a semicircle with the width of the rectangle as its diameter. From the extremities of this diameter describe arcs, equal to the radius, intersecting the circumference. Construct thus a semi-hexagon. Draw vertical lines through the angles of the hexagon, thus completing the elevation of a hexagonal prism. On the middle face of this prism draw the design as it appears in the panels of Fig. 9. On the two adjoining faces, draw the design foreshortened in width to fit the narrower spaces of the receding sides of the hexagon.

On the base of the rectangle, Fig. 11, draw a semicircle; divide the circumference of this semicircle into nine equal parts. Through these points of division draw vertical lines through the rectangle and construct the foreshortened view of the grille-work as it would thus appear bent into a semicylinder.

Complete the figures carefully and place the title SURFACES AND SOLIDS and other lettered details in their proper places. In place of this sheet, IV (*a*), either of the next two may be executed.

39. Exercise II, Sheet IV (*b*).—On this sheet are shown two figures, one of an ornamental iron-bar knocker, and another of an ornamental sheet-metal lantern. The center

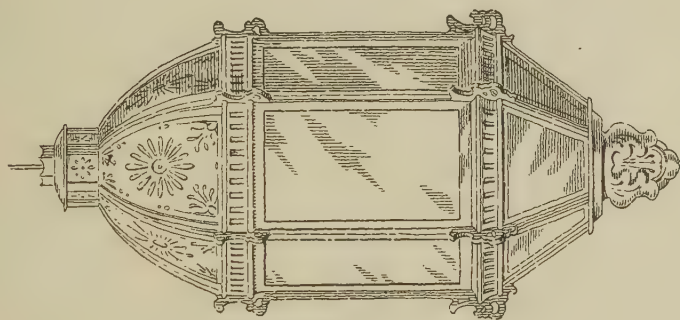


Fig. 2

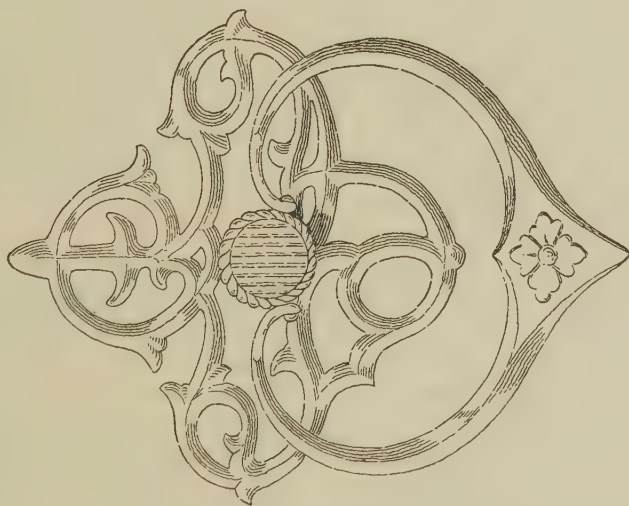


Fig. 1

line of Fig. 1 is $3''$ to the right of the left-hand border line, while the center line of Fig. 2 is $2\frac{1}{2}''$ to the left of the right-hand border line. These center lines should be drawn first, and the other details worked out from them. The total height of Fig. 1 is $6\frac{1}{2}''$; this height should be laid off on the center line. A horizontal center line should be drawn at right angles to the vertical one, about $4\frac{3}{4}''$ or more long. The circular boss about the center of the knocker is exactly $1''$ in extreme diameter, and is above and tangent to this horizontal line.

In constructing this figure it will be advisable to lay out an irregular hexagon to bound it. Two angles of the hexagon will be at the top and bottom of the figure, and the two sides can be located $2\frac{3}{8}''$ each side of the center line. The lengths of these sides should then be laid off $1\frac{1}{4}''$ above and below the horizontal center line, making them each $2\frac{1}{2}''$ long. Lines drawn from the sides so formed, to the top and bottom points of the figure, will construct an irregular hexagon within which the principal details of the figure may be formed. The large lower curves will be tangent to two sides of the hexagon, and the two large lower curves of the knocker and the outside curves of the wall piece of the knocker will extend somewhat beyond the sides but be tangent to the upper lines of the hexagon.

The construction lines as described can be laid out on the illustration of Exercise II, Sheet IV (*b*), given on page 44, and the other details located therefrom. Any desired measurements may be taken and transferred, as the finished drawing is to be about twice the size of the illustration, as is the case in all of the examples of freehand drawing herewith given. Great care must be exercised in shading this figure in order that the lines may not run into each other and cause dark spots. These shade lines must be drawn very slowly, as described for Exercise I, Sheet I, and kept parallel.

Commence drawing Fig. 2 by laying out a rectangle $1\frac{1}{8}''$ wide and $2''$ high as the central light of glass in the lantern. The bottom of this rectangle will be $2\frac{3}{8}''$ above the extreme

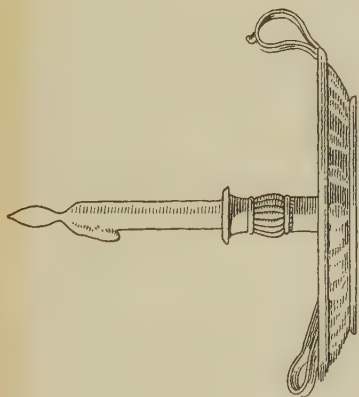


Fig. 1

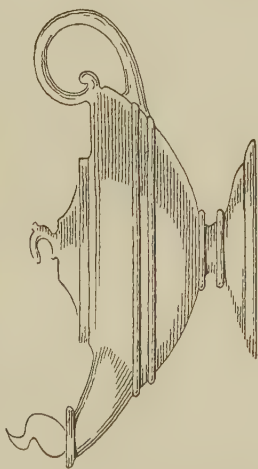


Fig. 2

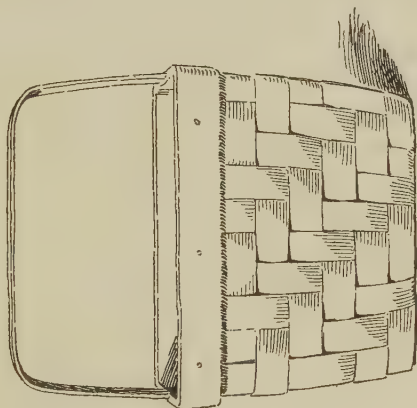


Fig. 3

lower point of the ornament on the bottom of the lantern, and the total height of the lantern on the center line from its ornament to the top of the cap is $6\frac{3}{4}"$. Having located the bottom of the boss, or ornament, hanging below the lantern, measure up on the center line $1"$ and draw a horizontal line locating the bottom of the slanting portion; $1"$ above this, another horizontal line will mark the top of the slanting portion; $3"$ above this, another horizontal line should be drawn locating the commencement of the curved portion; and one above this $1\frac{1}{4}"$, where the top of the curved dome unites with the cap, which latter is $\frac{1}{2}"$ high. With these points located and the $1\frac{1}{8}" \times 2"$ rectangle indicating the glass light, the details of the central section of this lantern can be carefully worked out. The details of the two side lights can then be worked out. Assume the central portion of the lantern to be the elevation of a regular hexagonal prism, then the two side lights represent the receding sides. Above or below the lantern construct a hexagon whose sides will be $1\frac{1}{8}"$ each, and project from this hexagon lines into the drawing to get the width of the side lights and accessories. Finish up the drawing and shade it as shown, taking every precaution mentioned in connection with Fig. 1. Place the exercise number and sheet number at the top, together with the title SURFACES AND SOLIDS, and the date, name, class letters and number, and time occupied, in their usual places at the bottom of the sheet.

In place of this Sheet IV (*b*), the next one, Sheet IV (*c*), may be executed.

40. Exercise II, Sheet IV (*c*).—On this sheet are to be drawn three simple figures, two in elevation and one in parallel perspective. These figures are every-day objects and are likely to be found useful in several schemes for simple drawings and designs. The center line of Figs. 1 and 2 is $3"$ to the right of the left hand border line, and the base of Fig. 1 is $4"$ above the lower border line, and that of Fig. 2 is $1"$ above. Locate Fig. 1 by drawing a horizontal line through its center line representing the base. Make this horizontal line $4"$ long, or $2"$ each side of the center line.

Above it lay off $3\frac{1}{2}''$ on the vertical center line, and from the points so located draw lines to each end of the base line. A triangle $4''$ wide and $3\frac{1}{2}''$ high will thus be constructed within which the figure should be drawn. The sides of the triangle will just touch the upper edge of the tray forming the bottom of the candlestick; the under side of the tray slants inward at an angle of 30° . The other details can be readily located after the main lines are constructed, and when the figure is shaded the lines should be carefully laid on, care being exercised to prevent them running together.

Fig. 2 is also drawn with a triangle to govern the construction lines for its contour, but in this case the triangle is inverted. First erect a vertical line $3''$ to the right of the left border line. Now, $1''$ above the lower border line, cross this vertical line with a horizontal line about $2\frac{1}{4}''$ long, which will serve as the base line of the lamp. $2''$ above this base line draw a horizontal line $5''$ long, and draw lines connecting its extremities with the center of the base line. This will form the desired inverted triangle. Now, $2\frac{9}{16}''$ above the base line, establish a center and with a radius of $2''$ draw a semicircle, the lower part of which will be tangent to the sides of the triangle and will form the contour of the body of the lamp. Draw a horizontal line $1\frac{3}{4}''$ above the base line to form the top line of the main body of the lamp. The lid or cover comes above this line. The remaining details can easily be sketched in.

Fig. 3 is located midway between Figs. 1 and 2 and the right border line. Its total height is $4\frac{1}{2}''$ to the top of the handle; the width of the basket at the bottom is $2\frac{3}{4}''$, and the width of the handle at the top between the vertical uprights of the handle is $3''$. The band around the top of the basket proper is $3\frac{1}{2}''$ long in front and projects its own thickness beyond the body of the basket. The effect of perspective is obtained by showing the back of the basket and its receding sides inside. Draw this as shown, shading very slightly, and indicating the basket-weave work. Letter the title SURFACES AND SOLIDS and the exercise and sheet

number at the top, and the date, time consumed, name, and class letters and number at the bottom as usual.

Of these last three sheets, some will find the work more difficult on one than on the others, and care should be taken with whichever one is attempted. A careful study of the original must be made, so that the pencil drawing is entirely satisfactory before sending in the work.

Do not send us your drawing of this exercise for correction until after Exercise I, title: Linear Elements, is returned to you with corrections and criticisms. Then note carefully the errors pointed out and see that similar ones have not been made on your Exercise II, title: Surfaces and Solids. When any necessary corrections have then been made on your Exercise II, title: Surfaces and Solids, it should be sent to the Schools for correction; your attention being next given to Exercise III, title: Natural Leaves.

EXERCISE III, TITLE: NATURAL LEAVES

41. Exercise III consists of twelve figures, each representing some form of a natural leaf, and is to be executed in pencil, as in previous work. In making these pencil drawings, they should first be sketched carefully with a rather dull, hard pencil, thus making very light lines that can be easily erased for correction. Use no more pressure on the pencil than is required to make a visible line. When this outline is sketched satisfactorily, each leaf should be finished up with a somewhat softer pencil sharpened to a long, fine point. This pencil must be used very lightly, or the lines will become blurred in handling, giving the drawing a very untidy appearance. Too soft a pencil should be avoided; first, because it cannot be maintained at a sharp point, and second, because it will soil the drawing. The work on this exercise is intended to familiarize the student with the characteristics of each kind of leaf represented and to accustom him to the study of the botanical and geometrical details of all vegetable forms used in design. Studies from actual specimens of leaves and flowers are to

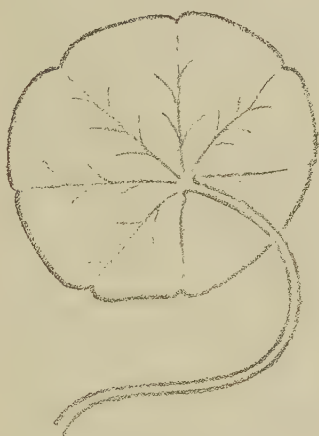


Fig. 1

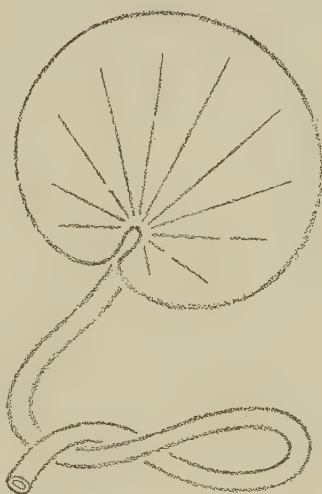


Fig. 2

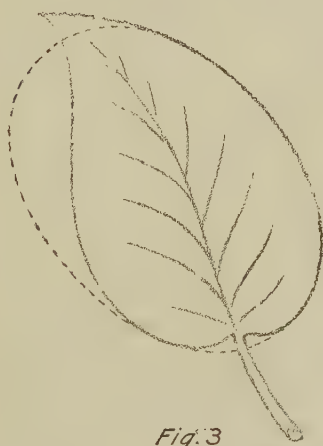


Fig. 3

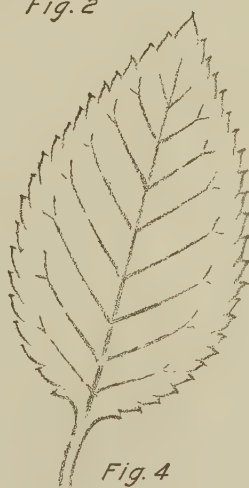


Fig. 4

be preferred to those shown on the printed copies; these, however, should be supplementary to the regular exercises. Send regular exercises whether or not you send original studies. Nearly all leaves and flowers are governed in outline by some geometrical figure, and by varying this outline slightly, various leaf forms are made different, while the leaves are at the same time governed by the same geometrical figure.

42. Exercise III, Sheet I.—This sheet includes Figs. 1 to 4, and is laid out by dividing the plate vertically and horizontally by center lines, thus making four equal rectangles in which the figures are properly proportioned.

Fig. 1 is the leaf of the Nasturtium, the governing outline of which is a circle. First draw, lightly, a circle about 3" in diameter, the exact dimensions being of no great importance. It will be observed that there are seven sides or



FIG. 22

lobes to the leaf, the lower one being the largest, and the others unequal. These lobes are expressed by making slight notches in the circumference of the circle and then rounding them off into the main curve. The stem joins the leaf not on the edge but at a point about one-third the way up, and from it radiate seven veins, each toward one of the notches in the circumference of the leaf. It will now be observed that two of these veins form an almost straight line across

the lower portion of the leaf, above which three of the veins radiate at almost equal angles. These are geometrical characteristics of the *Nasturtium* leaf, and if followed out will enable the student at all times to present a fair portrayal of this class of vegetation. When used for embroidery work and other classes of design wherein a softness of outline is more consistent with the character of the material, the leaf may be expressed more freely, as shown in Fig. 22 of the text. In drawing figures of this exercise, do not actually copy them. The work will not be judged according to the accuracy compared with the copy, but according to the clearness with which the object portrayed is represented. If it is possible to procure a *Nasturtium* leaf from the plant, make a drawing of that, using the characteristics in this description as a guide in the procedure. As has been said, "A drawing is the expression of an idea by means of a picture," and the work on these plant forms will be judged by the clearness with which an idea is expressed rather than by the accuracy with which a figure is copied.

Fig. 2 is a leaf of the pond lily; this also is based on the principle of the circle, but with an even circumference that is deeply indented at the bottom. At the point of indentation, a long stem joins the leaf, from which thin veins radiate toward the circumference. The length of the stem is a matter of little importance, as in nature it is governed by the depth of the water in which the lily is growing. In size the leaf may be the same or slightly larger than the *Nasturtium* leaf, and the stem may be curled as shown on the drawing; though if the drawing is made from the actual lily leaf, instead of this copy, the stem may be drawn as it is in the original.

The leaves shown in Figs. 3 and 4 are characteristic of a number of plants, and vary in size with each plant. Their governing outline is practically an ellipse, as shown by the dotted lines. Draw for them two ellipses about $3\frac{3}{4}$ " in length by $2\frac{1}{2}$ " in width, as shown by the dotted lines, and then draw one side of Fig. 3, corresponding closely to the circumference of the ellipse. The other side diverges from



Fig. 5



Fig. 6



Fig. 7

the ellipse as shown, the leaf being pointed at its upper end and slightly indented at the bottom. A long vein extends from the stem of the leaf, which joins it at the bottom indentation, almost to the point at the top, and the side veins branch to the right and left. After the drawing is completed, the construction lines may be erased.

The drawing of Fig. 4 is precisely the same as Fig. 3, except that the edges of the leaf are serrated or notched, as shown, and there is no indentation at the bottom, the leaf ending in a point at that end also, but more abruptly than at the top. This is the style of leaf characteristic of the rose and of the elm tree, though on the former plant it forms one of a group of leaflets, and is seldom more than half this size.

Having carefully completed the figures, draw the border line. Then letter the title, exercise number, sheet number, etc. in their accustomed places.

43. Exercise III, Sheet II, includes Figs. 5, 6, and 7. The spray of leaves in Fig. 5 is from the maple tree, and their governing outline is a pentagon, not a regular pentagon with equal sides, but one whose base is considerably longer than the other four sides. The indentations in the top lobe are more marked than those in the side lobe, and vary in different leaves; in fact, no two leaves are ever exactly alike, though the characteristics are always the same, and there should be no difficulty in portraying a maple leaf so that it is unmistakable for this class of vegetation. The lower lobes of the leaf are sometimes rounded, and in the younger leaves the indentations are much less marked than in the mature ones. In drawing the spray shown in Fig. 5, draw the large leaf first, and fit the smaller ones in under it, as shown, not necessarily following this exact arrangement, but placed in such a manner that they will show the characteristics of the leaf. Maple leaves are easily



FIG. 23

obtained in nearly all communities, and the student should certainly draw this figure from nature, if possible. The maple leaf can be characteristically and conventionally designed within the sides of a regular pentagon, however, as shown in Fig. 23 of the text.

Fig. 6 is a cluster of one class of horse-chestnut leaves, the governing outline of which is practically a hexagon. Each leaf is complete in itself, but as they always grow in a cluster at the end of a stem, with almost invariably the same number in a bunch, it is proper that they should be so represented, especially in design, as this is one of the geometrical characteristics of their botany. The true horse-chestnut leaf has invariably seven leaves in a cluster, arranged in the same manner as this example, but there is another variety of the same tree that has either five or seven in a cluster. To draw Fig. 6, first construct a general outline of the group as explained on page 5, and then draw in the individual leaflets. The general outline will be somewhat the shape of a hexagon, with the outside points of the leaves and extremity of the stem in each of its angles. In drawing the leaves, observe that they are larger at their outer ends than toward the stem; that the notches in their edges extend into the leaf toward the stem, and are not sharp, straight lines, but curved in the same direction as the veins of the leaf. The last point at the extreme end of the leaf is considerably longer than the others, and tends to give a spear-like termination. The peculiar form of the leaves permits them to cluster nicely in a bunch, as shown, and enables them to be conventionalized and easily used in certain forms of geometrical designs.

The first six figures of this exercise will serve to familiarize one, as far as is necessary, with the geometrical and botanical characteristics of these particular forms. Make it a point, however, to study other forms, and broaden the knowledge as much as possible in the observation of nature. Frequently, draw the leaves of different plants, and if the drawing does not convey a satisfactory idea of the leaf itself, analyze it carefully, and also the natural leaf, and learn

wherein some detail that stamps the character of the original has been altered or omitted. These leaves have been drawn singly because they are usually seen singly on the trees, or on the ground under the trees, with the exception of the horse-chestnut leaf; they are seldom associated in the mind as clusters. In the next six figures, however, a class of leaves is considered that are associated with the vine or plant on which they grow, and their characteristics must be considered, not singly, but together with the plant and surrounding details. Figs. 1 to 6 represent, also, a development in botanical evolution, the theory being that the fundamental leaf form was circular, as in Fig. 2. The notches in the outline of Fig. 1 are indicative of a lack of nourishment being conveyed to the margin of the leaf at certain points, thereby retarding its growth; the serrations in the edges of Fig. 4 are caused by a similar lack of circulation of sap, until finally we come to Fig. 5, where the serrations are so developed as to make lobes on the edges of the leaf, and in Fig. 6 to cause the leaves to grow in clusters at the end of one stem, instead of a single leaf. The different forms of the edges of leaves so developed are due to the system of veining. A study in comparison of different forms of leaves will soon place one in a position to judge and recognize the proper veining of a great many leaves, according to the indentation of their edges. The *Nasturtium* leaf is indented regularly at the end of each vein, and the veins are regular and straight. In the maple leaf, the indentations are very irregular, because the veining of the leaf is irregular and forms a network throughout the whole tissue. In the horse-chestnut leaf, the general veining is regular in each individual cluster, thereby causing an even subdivision into a uniform set of individual leaflets, while the edges of each leaflet are serrated, owing to a slight irregularity in their individual veining.

Fig. 7 is a spray of the vine and leaves of the *Convolvulus*, which is of the class of vine to which the morning glory belongs. Do not attempt to draw this until the drawing of the individual leaves of the plant have been frequently

practiced on separate pieces of paper. The number of leaves on the stem will depend on the object being drawn. If it is possible to secure a slip of the vine itself, draw it as you see it, locating the leaves as you see them. Do not attempt to copy this exercise, but refer to it for the expression of the stronger characteristics of the growth. If a slip of the plant cannot be obtained, make the drawing from the plate. The leaves of this example are triangular, slightly indented at the bottom, and manifest a strong inclination to curl up slightly at the edges. They are a soft leaf, and rarely lie stiff and flat, like the maple. In drawing them, observe the character of the veining, the arrangement on each side of the main stem, noting that they branch alternately, and that no two of them start from the same point. The leaf that is turned over, showing its under side, indicates the method and manner of the stem joining the surface, and in making the drawing bear in mind that the governing principle is an isosceles triangle, as shown in Fig. 24, and that the arrange-



FIG. 24

ment on the stem is an alternation on opposite sides. Observe, particularly, that the stems of the leaves, where they branch from the parent stem of the plant, have a little knob or enlargement that marks the joint. This is also the case in Figs. 8, 10, and 11, and is rather more perceptible in the last two than in Figs. 7 and 8. This enlargement of the stem is characteristic of growing plants, and should be carefully noted in the drawing. The figures are left in outline as before, the border line and lettering being placed at their accustomed places.

44. Exercise III, Sheet III, includes Figs. 8, 9, and 10. Fig. 8 is a spray of ivy leaves, each of which may be drawn within a pentagon, as shown in Fig. 25 of the text, in the same manner as was described for the maple leaf. The edges of the ivy leaf are not serrated, and the sides of each lobe are distinctly curved. Each leaf has five lobes; the



Fig. 8

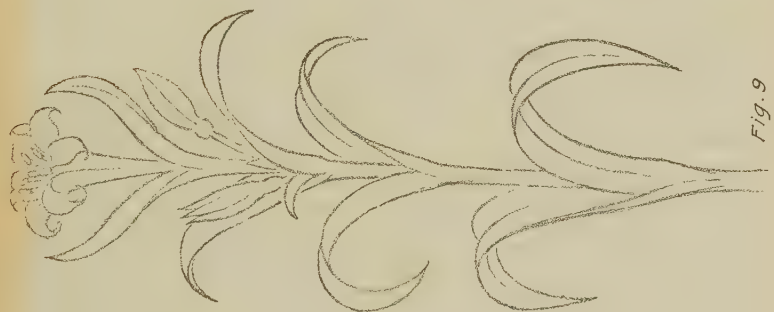


Fig. 9



Fig. 10

stems join them in a stiff, angular way at the lower indentation, and are heavy in proportion to the size of the leaf. The leaves do not show the wavy outline of the morning

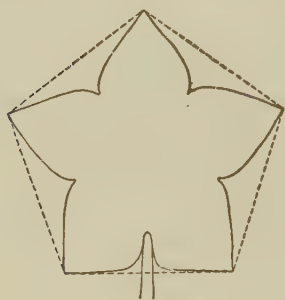


FIG. 25

glory, for they are naturally stiff and somewhat clumsy. The stem from which the leaves branch is of a woody texture, and is much stiffer and harder than the stem of the morning glory; therefore, it does not grow in a wavy line, and care should be taken that, though the ivy is a vine and manifests as strong an inclination to climb as does the morning glory, it does so

in a stiffer and more regular manner—a characteristic that should always be expressed when it is used in design. Draw Fig. 8 as shown, or from the natural leaves, if such are obtainable.

Fig. 9 shows the long stem of the lily. There are several classes of lilies that manifest different characteristics in some of their details. This view shows the principle on which the leaves branch from the stiff stem, their tendency being to grow upwards toward the flowers, which bloom at the top. Each individual leaf is a plain straight blade, sometimes with a strongly marked central vein, and at other times with a number of veins running through it. Its lower end wraps itself partly around the stem, and in some classes, such as the tiger lily, the flowers blossom at the junction of the leaf and the stem, and after the flowers have blossomed a round seed marks the place where they stood on the stem.

Fig. 10 is a branch of the olive tree—a very difficult specimen to get from which to draw from nature, but an important leaf in design, as it has always been held as the emblem of peace. The leaf of the olive is long and narrow, very slightly widened at its upper end, somewhat after the general shape of the chestnut, but softer and not so conspicuously unequal. The fruit grows on branches under the

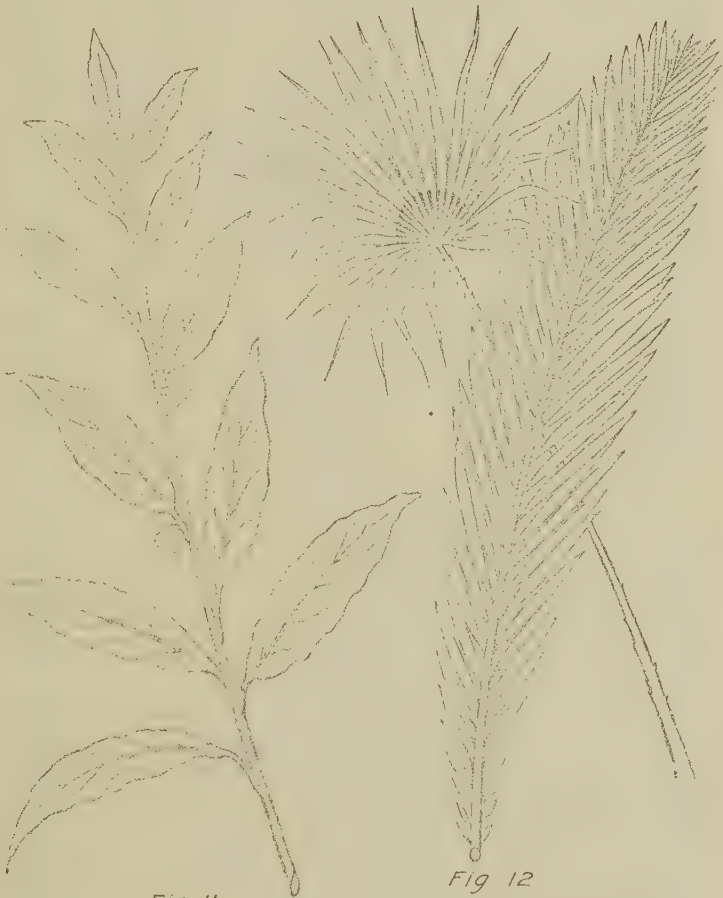


Fig. 11

Fig 12

leaves, with six or eight olives on each branch. In drawing this little spray, it is necessary first to indicate the main stem about as shown in the exercise, and draw the two leaves that terminate at its upper end. The next two leaves below these grow out of opposite sides of the main stem, from the same point in height. They are not directly over the ones below or under the ones above, but take a position half way around the stem from these, so that if the stem were so held that any two of its leaves pointed toward the north and the south, the pair next above and below them would point toward the east and west. This is a characteristic that should always be borne in mind in representing the plant.

45. Exercise III, Sheet IV, contains Figs. 11 and 12. Fig. 11 is a branch of laurel introduced here with the olive on account of its symbolism, the laurel wreath being an emblem of victory. The shape of the laurel leaf is not widely different from the olive, but it is much larger, being 3 inches or more in length, while the olive is seldom more than $1\frac{1}{2}$ inches or 2 inches. The leaves of the laurel grow all around the stem, branching alternately from opposite sides, and the edges, though not serrated like the rose leaf, are indented by a series of rounded notches at the end of each vein. The flowers of the laurel blossom in the angle between the leaf and the stem.

Fig. 12 shows two kinds of the palm—a plant emblematic of royalty. The palm leaf is used largely by the Egyptians in many of their designs, and from it were made several devices and utensils important in the ceremonies and customs of the complicated formalities of the ancient Egyptian society. In drawing the palm, observe that in one example the leaf radiates from the end of the stem, and bear in mind that though the edge is ragged and broken into a number of string-like terminations, its natural unbroken form is practically circular, and that the delicacy of the tissue composing the leaves causes them to be shredded on the edges when blown together in high winds or handled roughly when taken

from the tree. This variety is known as the *fan palm*. The other form of palm, called the *feather palm*, is similar in texture of leaf to the first, but its veins radiate from a line instead of from a point. The border line and lettering on this sheet are placed as before, and all the sheets of this Exercise III, NATURAL LEAVES, then sent to the Schools for correction.

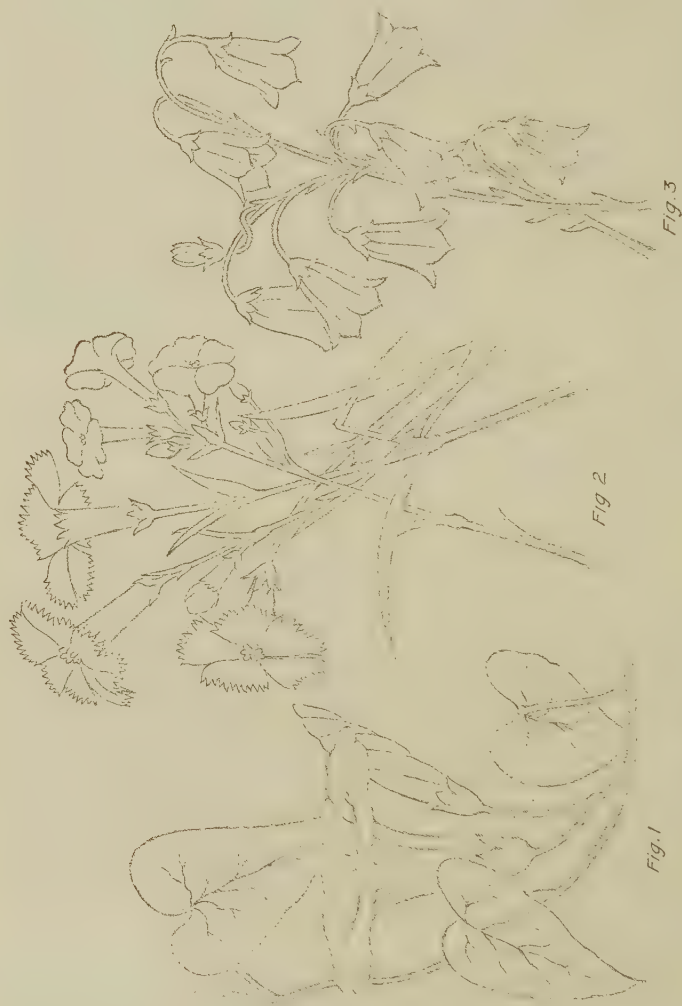
It is desired that the student should become accustomed to drawing rapidly and readily with the pencil and expressing himself with as few lines as possible. He must bear in mind that he is not to be a copyist, that no two leaves in nature are alike, and, therefore, it is unnecessary that he should portray any of the leaves in this exercise exactly like the example. However, he must remember that in each case he is solving a problem; he is endeavoring to express by means of a picture the idea of a certain form of leaf, and that failure to express all the characteristics of that particular leaf makes the solution of this problem incorrect.

EXERCISE IV, TITLE: FLOWERS AND CONVENTIONALIZED LEAVES

46. In Exercise IV, consisting of four sheets and including, in all, nine figures, there are given a few examples of familiar flowers, and the same remarks concerning the method of drawing and finishing them apply here as in the previous exercise. Original flowers are to be preferred to those shown on the printed copies, and whenever such are obtainable the student should avail himself of the opportunity to draw them. When such original studies are sent in, they should be supplementary to the regular exercise. Send regular exercise figures whether or not you send original floral studies.

47. Exercise IV, Sheet I, includes Figs. 1, 2, and 3, which should be neatly arranged across the 8" dimension of the sheet, each one occupying one-third of the space.

In Fig. 1 is shown the morning glory, its bud, and the method of its branching from the vine. The flower itself is



trumpet-shaped, the upper end being practically circular, which makes it elliptic when shown in perspective, as it is here. The sides of the tube forming the lower part of the flower are curved slightly, and gradually approach a straight line toward the stem. Observe that where they join, the little leaves around the bottom of the tube have pointed ends and form a cup called the *calyx*, in which the trumpet-like flower sets. Observe that the bud of the flower is twisted, producing a screw-like effect, as shown to the right of the open blossom.

Within this ellipse, describe the slightly scalloped edge of the upper portion of the blossom. For the top of the blossom draw an ellipse about $2\frac{3}{4}'' \times \frac{5}{8}''$. Draw the lines forming the trumpet-like tube of the lower portion of the blossom 2'' deep, and then draw the stem. The main stem of the vine runs from the lower right-hand to the upper left-hand corner, and by noting where it crosses the upper edge of the blossom, its position on the plate can be determined with sufficient accuracy. The leaves and the bud may then be drawn in their relative positions.

If the flower is drawn from nature, as heretofore suggested, these directions need not be closely followed, except so far as they apply to inserting each problem in its proper rectangle.

Fig. 2 shows two flowers somewhat alike in their general formation, but possessing characteristics that stamp them so forcibly that it is impossible to mistake one for the other; these are the phlox and the carnation. Both flowers possess five petals radiating from the center. The petals are larger at their outer ends and taper almost to a point where they come together. They enter the top of an almost straight tube that is held at the bottom by the little green calyx, where it joins them to the stem. This tube, however, is larger in the carnation than in the phlox, and the carnation itself is a larger flower than the phlox. The edges of the petals of the carnation are toothed very sharply and very plainly, while the edges of the phlox are round. The outlines of the ends of the flowers are practically governed by a

pentagon, and in drawing them be careful to emphasize the characteristics of each, the strongest distinctive characteristics being the round petal of the phlox and the toothed petal of the carnation.

The outline governing the ends of these blossoms is practically elliptic, although the edges of the petals vary more in the carnation than they did in the morning glory.

In drawing the phlox, observe that the petals of the flower form a part of the tube that connects the flower with the stem, thus differing from the carnation, where the petals grow out of the tube. The outlining of the petals is practically the same, though on a smaller scale, and the governing outline of the top of the flower is an ellipse, as in the previous cases. Observe that the blossoms of the phlox are all on one stem, while with the carnation each separate stem carries a flower. The exact arrangement of these flowers in the exercise is not of importance as long as they are all within the border.

In Fig. 3 is shown a couple of sprays of a little flower known as the harebell. The flowers themselves are cup-shaped and hang from fine thread-like stems that grow alternately on opposite sides of the main stem. It has no large leaf like most flowers, but a series of little spur-like projections along the stem, as shown. The edges of the flower are indented by fine notches that curve in from the top, and the spaces between these indentations rise to little sharp points, giving the flower a very pretty and strongly characterized marking. The bud, as shown at the top of one of the sprays, is formed by the ends of the flowers closing over and folding themselves within, and does not twist around like the buds of the morning glory. In drawing the figure, try to keep the flowers in a graceful position; also, prevent any appearance of stiffness or forced regularity, and especially be careful to draw them with a light delicate touch, avoiding a crude hard line, as one of the strongest characteristics of this flower is its delicacy, and this would be destroyed by too harsh a rendering of the pencil. The border line and lettering should then be placed at the proper places.

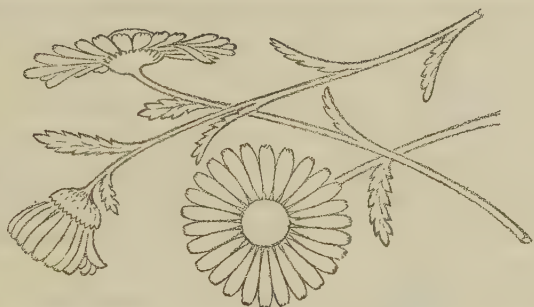


Fig. 5



Fig. 6



Fig. 4

48. Exercise IV, Sheet II, includes Figs. 4, 5, and 6. Fig. 4 shows the ordinary dog-rose, the flower possessing five petals, which radiate from the center and are slightly curled up on their outer edges. Where they join, a series of fine hairlike filaments (botanically known as pistils) mark the center. The leaflets grow on opposite sides of a thin stem, usually three on each side and one on the end, and the edges of the leaves are sharply serrated, as explained on previous sheets. The thorn is characteristic of all kinds of roses, and should always be expressed as a characteristic of the plant.

Fig. 5 is the common field daisy—a flower easily obtainable during the month of June, and a very interesting subject for various classes of design. It grows at the end of a long stem, at the lower part of which the ragged leaves branch and spread on the ground. The flower itself varies in size from 1 inch to $1\frac{1}{2}$ inches in diameter, is practically circular in outline, and consists of a number of white petals that branch from a central disk or sun in the center, about one-fourth the diameter of the whole flower. The petals vary in number, and branch out thickly on all sides, forming a solid white disk. The side view of the daisy shown in this exercise illustrates the tendency of the leaves to grow upwards slightly, and also shows the thickness of the sun or center piece below the petals of the flower. In drawing the daisy, it is well to sketch in the outline as a circle, and to draw the sun as a circle, and then, one at a time, indicate the petals or rays that branch around the edge. The petals are rather wider at their outer end than in the middle, and taper almost to a point where they sprout from the flower; two deep notches in the end cause three teeth to be characteristic of their outer extremities.

49. Plant Analysis.—Besides drawing the examples of wild flowers given in this exercise, every opportunity to study the flowers themselves should be taken; and after the details of each flower are drawn as seen in the blossom, the flower should be taken apart and analyzed. For example,

pull apart a wild rose and make an individual drawing of one of the petals, or all of them, as shown in Fig. 26 of the text. Then study and draw every detail of every part of the plant so as to become familiar with the characteristics of the plant as separate from the plant itself.

The leaves in their arrangement on the stem should be made the subject of another drawing, and this drawing of the details of the flower preserved as a guide to be used when the flower itself is expressed in a conventionalized design. The practice of thus drawing the details of a flower, or other vegetable form, is called **plant analysis**, and is the only



FIG. 26

way by which the strongest characteristics of every individual plant can be properly studied.

In drawing the foregoing figures, always outline the grouping first, as explained heretofore. Then draw the individual outline governing the extremities of the flowers, etc., and finally fill in and develop the detail.

50. In Fig. 6 is shown a panel in which is drawn a conventionalized design based on the growth of the ivy, and which is, with slight alterations, a suitable design for carved wood or burnt-leather work, or even for embroidery. The details are not so conventionally rendered as would be necessary for certain woven work, such as damask linen, or silk, but the two sides of the design are precisely alike, and the details all geometrically arranged so as to reduce the whole to a mathematical principle. In drawing the panel, make its dimensions $3\frac{1}{2}$ " wide by $6\frac{3}{4}$ " high, and divide it into eight equal rectangles, as shown in Fig. 27 of the text. Within these rectangles, draw a number of pentagons, more or less irregular, according to the outlines of the various leaves, and generally indicate the lines of the main stem of the vine where it crosses the dividing lines of the squares. Notice that

the center of the main stem crosses the center line of the panel ab about one-fourth of a square above the bottom, and it curves so as to cross the horizontal line cd a little less than one-half a square each side of the center line. The two stems then cross each other on the center line one-third of a square above the horizontal line cd , and they cross the

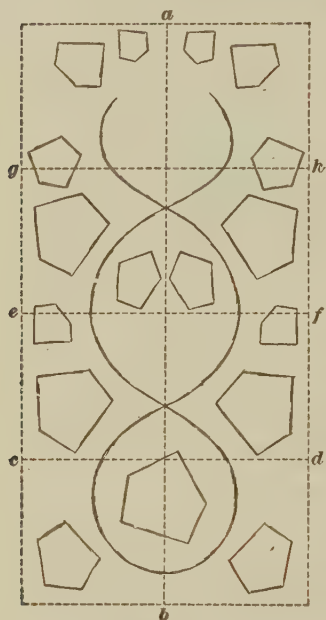


FIG. 27

horizontal line ef about one-half a square to the right and left of the center line. These stems then cross the line gh about one-third of a square each side of the center line ab , and cross each other on the line ab one-fourth of a square below the horizontal line gh . These measurements are not absolute and should be judged entirely by the eye. A principle to be observed is that the arrangement of the panel is based on the same rules concerning foliated ornament that were given in connection with Exercise I, title: Linear Elements. The strongest growth should be at the bottom, the arrangement of the leaves and area covered by

them should diminish toward the top, and, though it is not the nature of the ivy that its leaves should grow tangentially from the stem, the stems should be so arranged that they appear to grow gracefully and rationally, one out of the other, without abruptness or severity. The main stem, however, should be stiff, rigid, and geometrical, as explained in the instructions for drawing the ivy leaf in a previous exercise, as this stem is stiff and woody in its natural growth. Within the pentagons that have been drawn to indicate the locations of the leaves, carefully outline the five lobes of the ivy leaf and connect them with a gracefully curved stem with the

main lines of the growth. Enclose the whole design in a border line, as shown.

51. In using such a design as this for practical work, the relative sizes of the stems and tendrils may be materially altered. Certain materials and methods of handling permit a much more delicate treatment than is here shown, while other conditions demand that all the lines be bolder and that some of the details at the top of the panel be suppressed entirely. For instance, if the design were to be embroidered, the colors to be used would determine largely the strength of the line of the stem, dark colors always looking heavier than light ones. The curve and arrangement of the fine tendrils at the top would also be altered, as the tracing of these lines would be governed by the possibilities of the handling of the thread employed. If the design were to be carved in wood, the tendrils at the top would probably be omitted entirely, and heavier forms replace the smaller leaves. The nature of woodwork would not permit so delicate a treatment at the top, and as the omission of the tendrils would leave a blank space that would look unfinished, the leaves themselves should be enlarged to satisfy the feeling that the proper area at the top had been covered. In the smaller stems, throughout the body of the panel, the design would probably require strengthening, that it might be better expressed in wood, and their increase would require a general increase in the thickness of the main stem throughout, in order that the proportions of one to another might remain the same. After having carefully outlined these details, strengthen the general lines of the drawing, clean up the guide lines, and then finish the figure in pencil.

Place the border line and lettering at the accustomed places.

52. Exercise IV, Sheet III.—With Fig. 6 of this exercise we take up the first part of the subject of conventionalized forms. It is seldom that a plant or other form from nature can be used in a design with reason without reducing it to a plain practical form that is conventional or symbolic

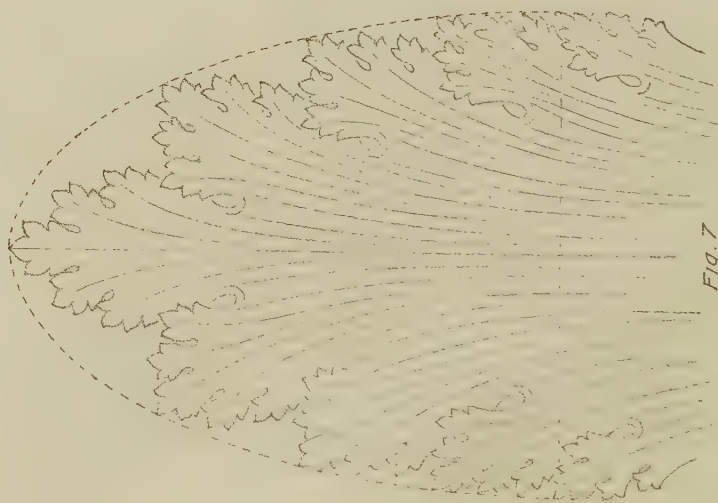


Fig. 7



Fig. 8

more than pictorial. Fig. 7 is a conventionalized form of the acanthus leaf, and as we draw it we will endeavor to get a better idea of the meaning of the word *conventional*. In the first place, the outline of this figure is based on the ellipse; therefore, construct a semiellipse $5\frac{3}{4}$ " high and 5" wide. Within this, draw the main outline of the lobes of the leaf, as shown in Fig. 28 of the text, observing that these lobes are farther apart as they approach the top of the leaf, or, in other words, are closer together at the wider portions of the leaf. There is a central lobe and three smaller ones on each side. The top lines of the side lobes are curved, but are nearly horizontal in position, and the side lines of the lobe are inclined slightly toward the center of the leaf. The middle vein is a straight line on the major axis of the ellipse, and the side veins curve from the points of the lobe to the bottom line, as shown, and approach the central vein as they reach the bottom; in other words, if all

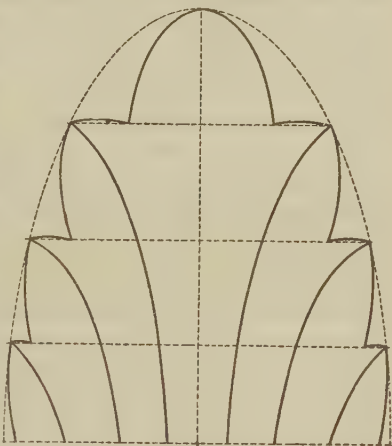


FIG. 28

the veins of the leaf were continued downwards, they would eventually meet in a point like the lines radiating from a point in Fig. 18 of Exercise I, title: Linear Elements. The acanthus leaf is now drawn by serrating the edges of these lobes, following the exercise as closely as possible. The inner angles of the lobe are then carried into the leaf in the form of loops, the vertical lines usually being the ones that govern the direction of the loop. The leaf lobes are then drawn as though lapping over one another slightly, and extra lines are drawn indicating the sides of the pipes or tubes that are naturally formed in the leaf where these loops exist. It will be seen that the sides of the leaf on this exercise are symmetrical, that the leaf is perfectly flat

in the drawing, and no attempt is made to shade it. The existence of the last line drawn from the loops down is indicative of the raised surface of the pipes on the leaf. This is the expression of an idea by means of a picture. It is not a picture of the acanthus leaf as it appears in nature, but a picture of the characteristics of the leaf—characteristics that are themselves emphasized beyond the mere drawing of the leaf itself, and it is the emphasis of these characteristics that distinguish in the drawing of a leaf or flower the naturalistic and the conventional rendering. Flowers and leaves may be rendered naturalistically if they are painted on canvas or printed on paper, but if woven in cloth or carpet, or used as a part of a wallpaper design, or burned in leather, the details of the process by which they are thus reproduced will not permit of an accurate portrayal of them naturalistically. They are therefore conventionalized, and lines indicating their strongest characteristics are woven, printed, or carved to stamp the leaf for what it is.

Fig. 8, Sheet III, is a side view of the conventionalized acanthus as it is sometimes used in connection with scrollwork on brackets. The S-like outline of the leaf is first drawn about $6\frac{1}{2}''$ high; the lower curve is then drawn to measure $3\frac{1}{4}''$ across; and the upper curve about $1\frac{1}{2}''$ across to the dotted guide line. The lobes are then outlined exactly in the same manner as the previous case, and the indentations drawn within these outlines, as before. The veins running from the center of the lobes are then drawn, following the contour of the lobe itself, and finally becoming tangent to the main curve at the outside of the leaf. After the leaf has been drawn, the guide lines, which are shown dotted in the exercise, may be erased and the drawing of the leaf itself completed.

The border line and lettering are then to be located as before.

53. Sheet IV.—Fig. 9 is a bracket and hanging sign, similar in every respect concerning its general outline to the bracket and sign in Exercise II, Sheet II. Draw the outline of this bracket and sign precisely as before, but where the

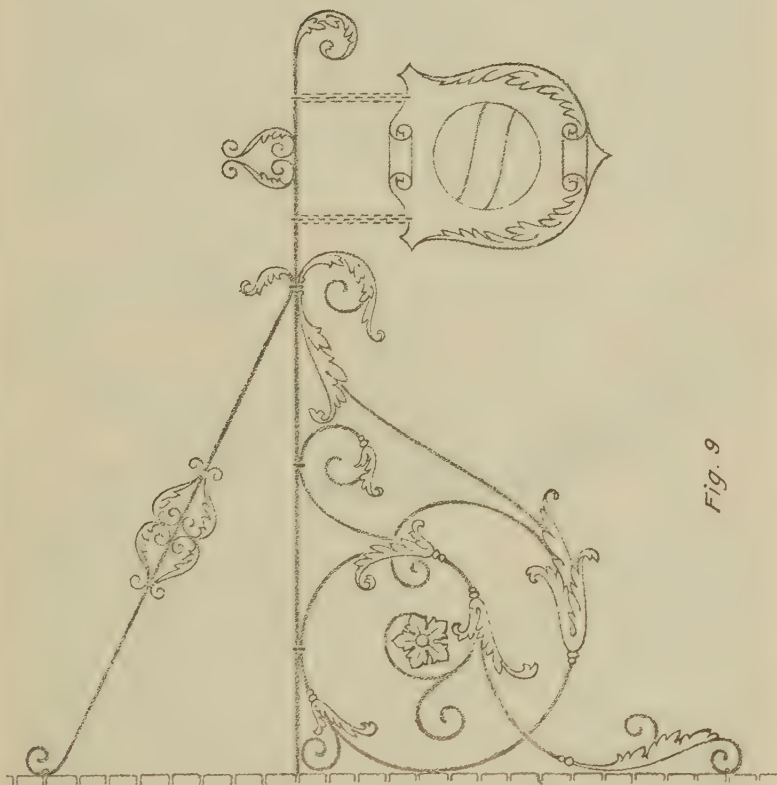


Fig. 9

lines of ironwork split and branch into separate scrolls, cover the joint with drawing of a conventionalized leaf, the details of which have just been studied. The length, size, and proportions of the different parts of the leaf must be judged by the eye, observing that the outline of the leaf follows closely the outline of the ironwork that it covers, and observing, also, that a plain strap-iron bracket is being converted into an ornamental device, requiring in its execution the greatest skill in the ironworkers' art. It is also well to know that in the execution of a design of this character for an ironwork bracket that might be used either as a sign hanger or as a design for a chandelier or gas bracket

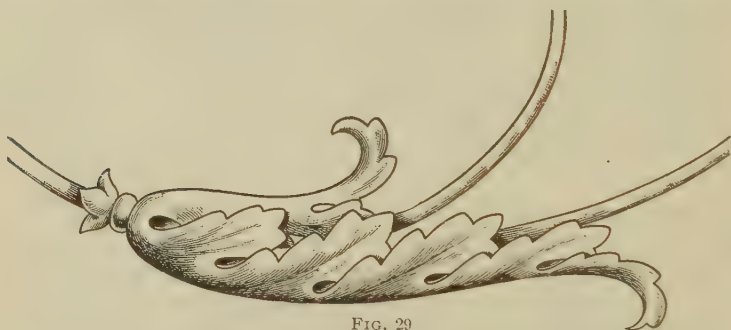


FIG. 29

it is necessary to exercise the same judgment in the formation of the leaf as was necessary when drawing the cartouch. The leaf must be cut out of plain sheet iron by the ironworker, and hammered into the shape expressed by the designer on his drawing. It is well, then, for the student to study what the developed shape of this leaf would be if it were flattened out. He will probably then find by experiment that the leaf can be improved in design by varying some of its dimensions. Fig. 29 shows a piece of iron scroll projecting from a hammered ornamental iron leaf, while in Fig. 30 a developed form of the larger part (the lower) of this leaf is shown in outline before it is hammered into this shape. It is a simple matter, and a very instructive practice, for the student to experiment in drawing and making these devices of paper or thin metal, as was suggested in the

drawing of the cartouch. Very thin brass or copper is an excellent material to practice with. It may be readily cut to any desired shape with ordinary scissors, and bent and creased with the fingers to bring it up to the finished shape, and the student that can both draw and model his designs will be in better shape to execute satisfactory compositions than the one that is simply satisfied to express his ideas on paper. The border line and lettering should be placed at their usual places. To save time and trouble the title may be lettered as FLOWERS AND LEAVES. All the sheets should then be mailed flat, as before, to the Schools for correction.

OUTLINE ORNAMENT.

54. In outline ornament, a figure is expressed by a series of lines that contour its principal parts. If the object be a rosette, as in Exercise V, Sheet I, the entire figure is expressed by a suitable outline, and the details of its surface expressed by other lines limiting their boundaries. It is impossible in this method of drawing to express rotundity or curvature of surface, and this is not intended, but where any portion of an ornament comes into sharp relief so that it is likely to cast a clean line shadow, then a clean line may be used to profile it. In design work in general, ornaments are worked up in this character, and a few of them are afterwards treated to express in detail the character of the whole. The drawing is thus simplified and the character of the design shows up to much better advantage than if every element of the ornamental surface was carefully finished.



FIG. 30

Take, for instance, the introduction of any one of these figures in an Arabesque design repeated at regular intervals over an entire wall surface. If all these repeated figures were worked up with the exactitude that rendered one a perfect duplication of the other, in color, light, and shade and outline, the effect would be monotonous and the eye would wander from one detail to another without resting and the scheme presented would not carry to the observer the same idea that it would if executed in this manner on the wall of a room. On the wall of a room the surface is so extended that the eye cannot take it in at a glance and therefore falls on an individual figure and unconsciously derives its impression of the whole room from the impression of the one detail. In rendering the drawing of any large surface treatment, it is therefore advisable to have only a few of the details worked up in a finished manner, so that the eye may appreciate these and receive of the others a general effect harmonious with the first.

Exercises V and VI will be in ornamental drawing, and the student may draw all construction lines for them with instruments, but the devices themselves are to be executed entirely freehand. A 3H pencil should be used for the construction lines, but a B or 2B should be used to finish the outlines and shaded portions of the ornament.

EXERCISE V, TITLE: OUTLINE ORNAMENT

55. To draw the figures in Exercise V none other than approximate directions will be given. It is intended that the student shall learn to discover for himself methods of proportioning the parts of a figure without receiving minute instructions for each line. The illustrations herewith shown are about one-half the size the student is to draw them, but no exact dimensions will be required as long as one part is properly proportioned to another.

56. Exercise V, Sheet I.—To draw the two rosettes on Sheet I, divide the sheet through the middle by a light

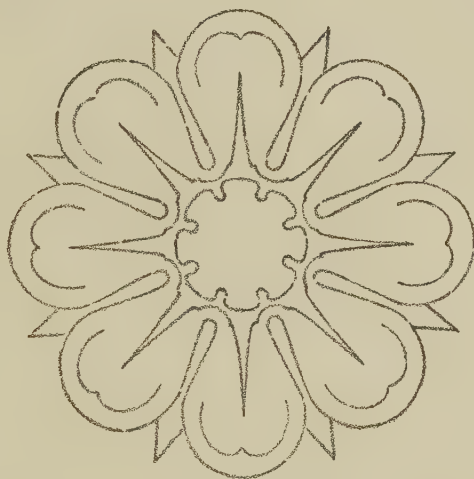


Fig. 2

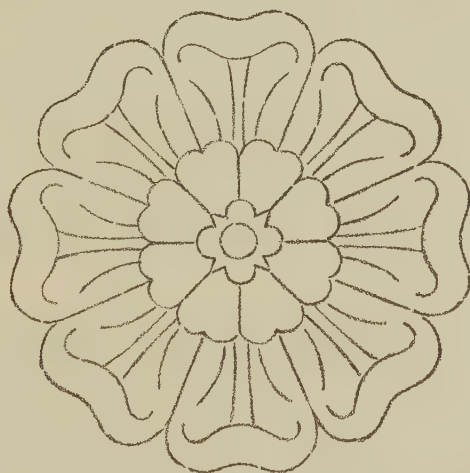


Fig. 1

vertical line, thus establishing two panels, in the center of each of which locate one figure. The best way to draw Fig. 1 is to draw in the center of the panel a square whose sides are equal to the breadth and height of the rosette, and then to construct an octagon within this square, according to Problem 18 in *Geometrical Drawing*. As this rosette has eight sides, each side of the octagon will mark one side of one of the leaf forms that constitute the rosette. The diagonals of the octagon will make the lines separating these leaves. After locating these details, the rest of the figure can readily be drawn in. Be careful to proportion the inner rosette to the outer one, and observe that the center detail consists of two sets of forms each—that is to say, four semicircles separated by four acute angles.

After completing Fig. 1, clean up the drawing and erase as far as possible the main construction lines. Then cover over this half of the sheet with a piece of paper to protect it while Fig. 2 is being drawn. Study Fig. 2 carefully. It can also be drawn in an octagon but the octagon will not be in the same position as in the case of Fig. 1. Devise a method of proportioning the different parts, and then draw in the rosette. *Do not erase* the construction lines in Fig. 2, but leave them so that we can see the method used.

After completing the sheet, letter it at the top with the title OUTLINE ORNAMENT and the number of the exercise and the number of the sheet, and at the bottom with the date, time consumed on the work, your name, and class letter and number.

57. Exercise V, Sheet II.—To draw Sheet II divide the paper within the 8" × 11" border as before, and in each of the two panels thus formed draw a vertical center line that will make the center of the two conventional flower outlines. The floral top of Fig. 1 is the widest part of the figure, and a horizontal line, representing this extreme width, should be drawn about one-fourth the height of the figure below the top. From the ends of this horizontal, lines should be drawn to the lowest part of the figure, thus

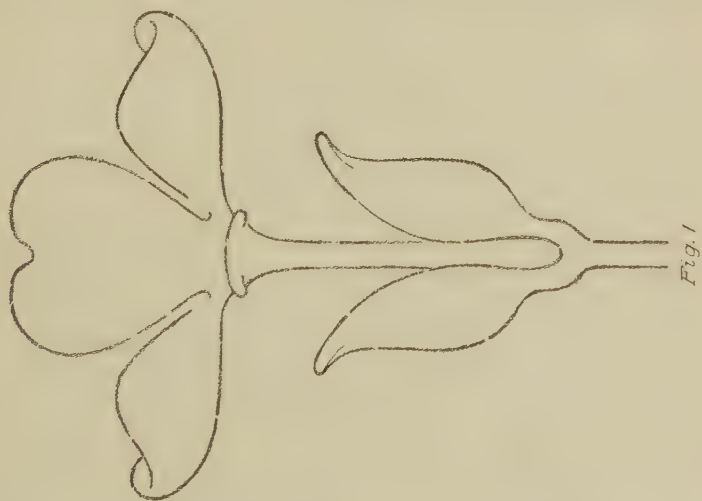


Fig. 1

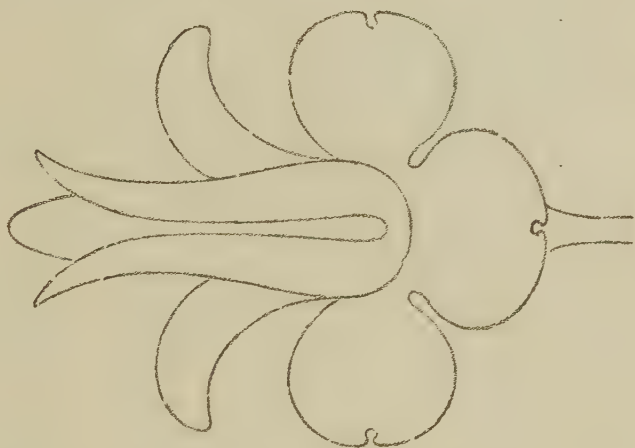


Fig. 2

constructing an inverted isosceles triangle. The sides of this triangle will be tangent to the lower part of the leaf forms that branch from the stem below the flower. Having constructed these guide lines with instruments, carefully draw in the outlines of the device, and when finished cover it with a protecting sheet of paper and proceed with Fig. 2.

The governing outline of Fig. 2 is an oval with its small end upwards, or if an outline for the whole figure, including the short lower piece of stem, is wanted, it can be drawn in an ellipse. In either case, the width of the figure across the two upper radiating leaves is about two-thirds the height, and a line drawn across this width, a little less than one-third the height from the top, will form the base of an equilateral triangle whose apex is in the edge of the lowest leaf lobe. Figures of this character are frequently found in the Arabesque ornaments so characteristic of Renaissance panels. Draw this triangle and then carefully outline the figure. Letter the title *OUTLINE ORNAMENT*, exercise number and sheet number at the top, and the date, time consumed, the name, and class letters and number at the bottom, as usual.

58. Exercise V, Sheet III.—Fig. 1 of Sheet III is developed on a skeleton of radiating lines similar to Fig. 18 of Exercise I. The extreme width of the ornament is at a point about one-third up from the bottom, and this width is about two-thirds the total height. The width across the overhanging leaves at the top is about one-half the total height. A line connecting the end of the overhanging leaf at the top with the end of the calyx leaf at the bottom will form a guide line by which the other details may be located. Draw the above lines in pencil on the illustration here, and then duplicate them, increased in scale, on your drawing sheet.

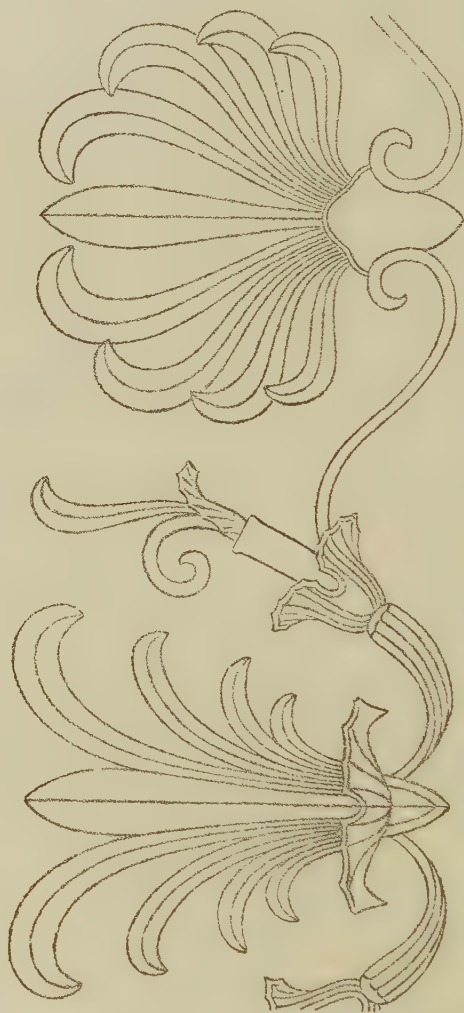
Fig. 2 involves a combination of Figs. 16 and 18 of Exercise I. Draw a horizontal line through the right panel of the sheet about three-eighths the height from the bottom. On this line lay off the width of the figure across the volutes; then, with the marked width on one side, construct a square to contain the entire upper portion of the figure. The



Fig. 1



Fig. 2



general outline of the radiating palmette form is a semiellipse whose semimajor axis is equal to its minor axis. The minor axis, which is also a side of the square just drawn, passes through the eyes of the volute. Draw in the outlines of the leaf forms and the volutes, and complete the figure as shown. The proportions of the volutes can be judged by the eye, as it is unnecessary to lay out their curves mathematically, as in Fig. 16, Exercise I. Letter the title OUTLINE ORNAMENT, exercise number, sheet number, name, class letters and number, etc., in their usual places.

59. Exercise V, Sheet IV.—The figures on Sheet IV are part of the running honeysuckle ornament characteristic of Greek art. The governing outline of the left-hand figure is an inverted triangle, while that of the right-hand one is a circle. However, neither outline conforms exactly to these geometrical forms, as will be seen by applying the form to the illustration. The vertical center lines of the two figures should be drawn about 6'' apart, and two parallel horizontal lines $4\frac{1}{2}$ '' apart should be drawn to limit the height of the ornament. The triangle and circle that are to form the governing lines of the two figures should be drawn with instruments and the details of the form filled in freehand. Letter the sheet as the preceding ones.

SHADED ORNAMENT

60. Shaded ornament bears the same relation to outline ornament in black and white designs as colored ornament bears to shaded ornament in color design. The outline must appear in shaded ornament just as much as in outline ornament, but need not necessarily be expressed by a hard and wiry line. It is an old saying in drawing instruction that "nature abhors an outline," and many authorities state positively that such a thing as outline cannot exist. This is a hard fact to understand as we immediately picture the definite outline of a green tree against the sky, or of a painted house against a thick foliage. We feel that the house actually possesses an outline, and should be so

expressed if rendered in a drawing or painting. It is the mechanical conception of this hard and fast line of the tree, as separate from its background, that prevents us from understanding the assertion that there is no outline in nature; but if we mentally picture a case where the tree, or the house, or any other object, no matter what, is of exactly the same value in light and shade and color as the background against which it was profiled, no line of demarkation between the two could be seen. Therefore, what we consider as the line between two such objects is simply the point where two shade values or two color values meet and one is thus seen contrasted to the other.

This should be borne in mind in making these drawings of shaded ornament. In each case, a delicate outline drawing should be made, and on that outline drawing the high lights, or those portions that are most brilliantly illuminated, should be carefully sketched. The line that marks them should be so light that it can be seen only as the work is being done, and should disappear almost entirely when the drawing is finished. The difference between one portion and another can then be expressed by bringing the shaded portion of the drawing up to the light portion and letting the limited shadow mark the line between the parts. Take, for instance, the simple leaf form in Fig. 1 of Sheet I. The entire right side of the form is in shade except the upper edge of the lower leaf lobe. The line separating the light portion on the left from the shaded portion on the right should not be considered as the outline, but simply as the meeting of two planes, one darker than the other. This line disappears almost entirely as we approach the top of the center lobe where two shaded portions come together. But the mind is so subtle and can so easily grasp what is intended by the merest suggestion, that it carries this apparent dividing line clearly to the point of the leaf, although no effort is made to preserve its identity there at all. This ornament is in low relief against the flat background. The leaf is expressed by the lines drawn beyond the shaded portions of all the leaves to express a thickness of material between the shaded lobe

and the background *m* here, even in shaded ornament, an outline is necessary because the high light of the background and the high light on the ornament itself must be distinguished. If this drawing were rendered in color, this distinction might be effected by a difference of hue. On the center lobe, the relief of the background is distinguished by a shadow cast in a deeper tone than the shade of the lobe itself.

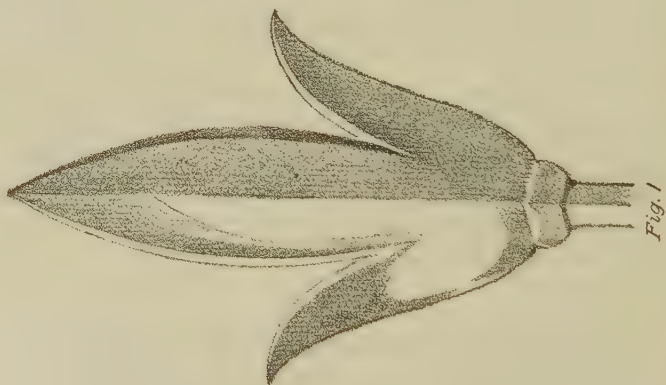
In shaded drawings, a distinction should be made between the shade and the shadow. The **shade** is that portion of the surface that does not receive as much light as some other portion, and varies in depth of tone according to the extent it is turned away from the light. The **shadow**, on the other hand, is that portion that is excluded from light almost entirely, owing to the presence of something in relief between it and the source of light. The shadow is always deeper in tone than the shade. In a cylinder, cone, sphere, or other curved surface, there is one spot that receives the full possible percentage of light; this is called the **high light**, and as the surface curves away from this high light it receives less and less illumination until the point is reached where there is none at all, and generally speaking is as dark as the cast shadow.

In rendering these drawings in shaded ornament, bear in mind that outlines are used only where they are necessary to separate two high-lighted portions from each other, and that in every case possible the line marking the boundary between two general surfaces should be expressed by shading one surface up to the point where it comes in contact with the other.

EXERCISE VI, TITLE: SHADED ORNAMENT

Exercise VI consists of four sheets, the execution of which gives practice in indicating the effect of light and shade on the surface variations of ornamental forms.

61. Exercise VI, Sheet I.—The conventional leaf form shown in Fig. 1 consists of three lobes, the two smaller ones



spreading in width to about two-thirds the entire height of the figure. Draw this form carefully in outline and then with a very light pencil line indicate the outline of the high lights on the left side. Draw a light vertical line through the center and then carefully shade the right side with a 2B pencil. The shading is composed of a series of even, parallel strokes sufficiently close together to form an even tint, but which on close examination exhibit their individuality as pencil lines. There is a slight variation in the depth of these lines, which can be observed by closing the eyes partially and viewing the figure through the eyelashes. The shadow to the right of the main lobe is somewhat deeper than the shade on the leaf itself and thereby throws the figure in relief. There is but slight difference between the center of the lobe and the edge, but at the same time there is a difference, and the lighter shade is at the right edge. The shade on the two smaller lobes deepens toward the top where the stripe of high light indicates that the edge is beveled.

Fig. 2 may be conveniently outlined within an ellipse whose minor axis is about two-thirds its major axis. Radiating lines should be drawn from the bottom of the ellipse locating the center ribs of the leaf lobes, and the outlines of the lobes then drawn. The vertical central rib extends to the top of the center lobe without diminution in width or projection; there it unites with a raised rim of the same size that follows the outlines of the lobes. This rim and the lateral ribs, however, diminish in width and projection as they approach the center of the leaf, where they die out entirely.

In shading this leaf, the lower and right-hand edges of the lobes and ribs should be emphasized slightly with a soft pencil and the curvature of the surface indicated as shown by a flat gray tint similar to that in Fig. 1. Letter this sheet in the same manner as the sheets in the previous exercises.

62. Exercise VI, Sheet II.—The three figures on Sheet II are shaded more after the manner that is to be recommended for conventional work. On Sheet I, the pencil lines were so close together that they appeared as an

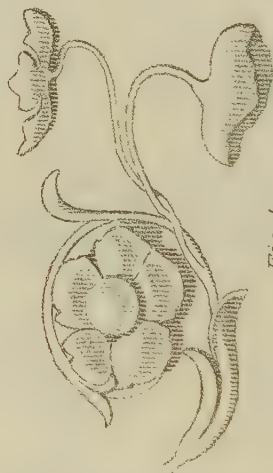


Fig. 1



Fig. 2

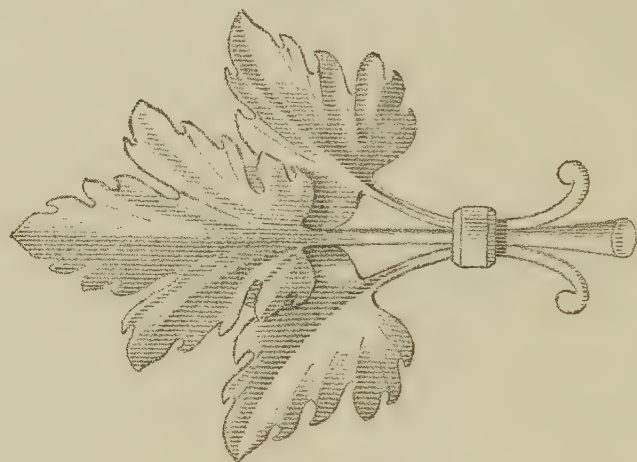


Fig. 3

even flat tint; on this sheet and those that follow, the shade lines should be separated sufficiently to show their individuality, and to vary their color by increase of pressure on the pencil in rendering them. The outlines of Figs. 1 and 2 are too simple to require description. The leaf part of Fig. 3 can be constructed within a square standing with one end of a diagonal at the vertex of the center leaf and the other end of the diagonal in the center of the ring or band uniting the stems of the three leaves.

The shading of Fig. 1 consists of simple short strokes even in tone and uniform in spacing, so placed as to show the shade on lower curved portions of the ornament. The shadows cast against the background should be made with a heavier stroke and a thin white line should be left between the cast shadow and the surface shade of the ornament. In shading Fig. 2, observe that the indentation at the central vein is expressed entirely by the shading, while a portion of the lower outline is expressed entirely by the shadow. Close the eyes partially and observe through your lashes the grading of each line in the rendering in order to deepen the shade toward the central vein. The shading on Fig. 3 is even in tone without deepening toward the vein, as in Fig. 2, but the lower and right edges are emphasized here and there to add character to the outline. Place the usual lettering on the sheet.

63. Exercise VI, Sheet III.—Draw Fig. 1 in a circle 5" in diameter, and Fig. 2 in a triangle 4" wide and $6\frac{1}{2}$ " high. The leaf forms of Fig. 1 should first be drawn in general outline, the five being arranged similar to the lobes in Fig. 2 of Sheet III, Exercise V, except that there will be but two lobes each side of the center in this case instead of six as in the previous case. Finish Fig. 1 of this sheet in outline and then carefully shade in the background, varying the weight and strength of the lines as shown. Short light strokes on the lobes of the leaves indicate their rotundity, and the emphasis of the outline throws the whole into relief.

In drawing the outline of Fig. 2, which is the crest of a

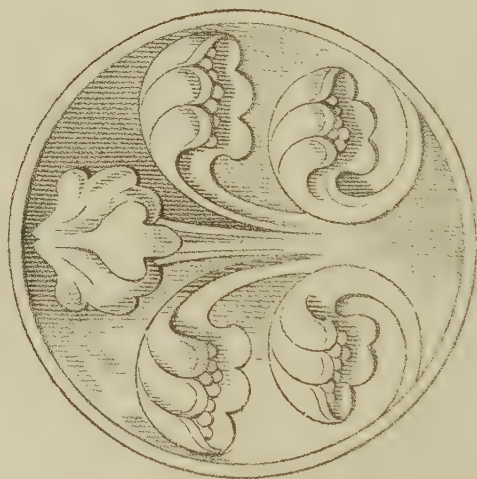


Fig. 1

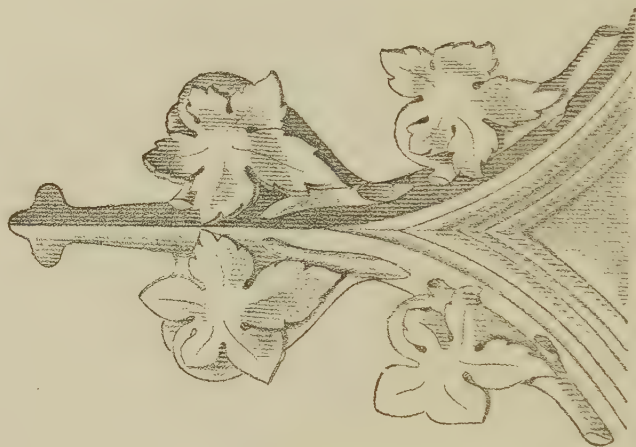


Fig. 2

Gothic gable, the vertical center line forms the rib of the pinnacle, which splits about half way up and curves out to the lower angles of the enclosing triangle with a radius of 4". The indicated moldings below this are parallel to this split rib, as shown. The sides of the enclosing triangle pass approximately through the centers of the carved leaves, which centers are about $2\frac{1}{2}$ " from the apex of the triangle and $1\frac{1}{2}$ " apart. Just enough shading is introduced into this drawing to indicate the curved form of the surface of the leaves and moldings and emphasize the shadow side of the pinnacle and its sweep to the right-hand corner. Letter this sheet in the same manner as the preceding ones.

64. Exercise VI, Sheet IV.—Fig. 1 of Sheet IV is drawn in a triangle whose base is 5" wide, and whose altitude is $6\frac{1}{2}$ ". The rib that marks the center line of the pinnacle splits just below the center of the height and branches into the corner of the triangle, as in Sheet III, at a radius of about 4". Of the foliated ornaments, the upper two are attached to the pinnacle itself, and the lower two are on the upper slopes of the gable. The upper ones spring from the pinnacle about 2" from the top, and the lower ones from the curved gable lines a little more than half way up the slope. These should be sketched in outline so that the extreme width across the upper pair is about 3", the lower ones being made in proportion. Their outlines should be very delicately rendered with a hard pencil so that the line is scarcely discernible, depending on the contrast between the light and shade values to determine the outline. The center line of the pinnacle and its outline, except at the top, had better be drawn mechanically, and also the curve where it splits and sweeps into the corners of the triangle. The other curves can be drawn lightly with the compass, if desired, but should be rendered freehand with a soft pencil afterwards in order to destroy the mechanical effect. The shading should be commenced with the pinnacle itself and carried out with a soft pencil, frequently sharpened, in order to preserve the individuality of line. Where the leaves of the foliated ornament

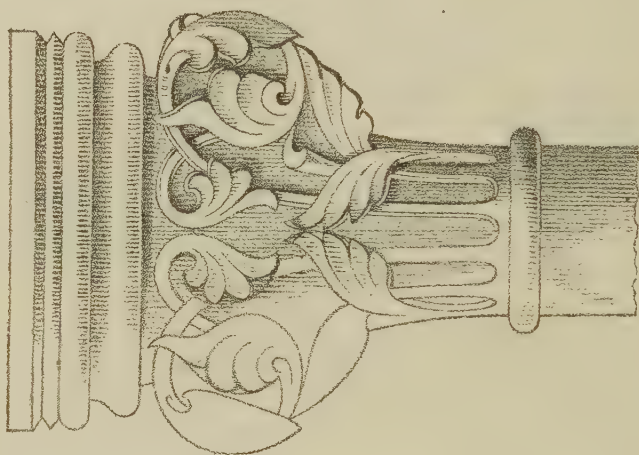


Fig. 2

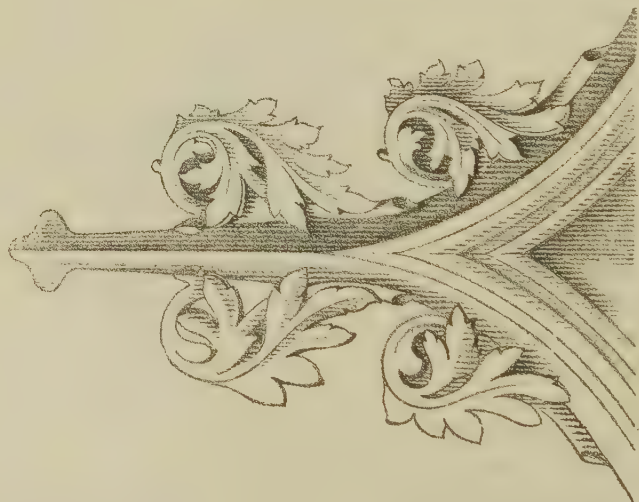


Fig. 1

extend over on to the shaft of the pinnacle, care should be exercised to preserve their outline simply by contrast. The left side of the pinnacle is shaded but slightly, in order to distinguish its outline against the white background, and the foliated ornament on the left side is drawn in outline only, whereas on the right side it is both outlined and shaded. The portions that are deeply cut should be emphasized in shading, in order to get the effect of a strong shadow. Observe that while the ornament on the left side of the pinnacle is drawn in outline only, that on the right side introduces more detail. The leaves end in three points instead of one, and the method of rendering partakes of the same character as did the acanthus leaf in Exercise IV.

Fig. 2 is a Norman capital. Its abacus or upper slab is about $4\frac{1}{4}$ " wide, and a little less than $1\frac{1}{2}$ " deep to the bottom of the moldings. The bottom of the necking where it joins the shaft is $5\frac{1}{2}$ " below the top of the abacus, and this necking is about $\frac{3}{8}$ " wide. The width of the shaft below the necking and at the capital above it is $1\frac{3}{4}$ ", but it spreads out in a slight curve about $3\frac{1}{4}$ " where it supports the first molding of the abacus. The width of the capital across the foliated ornament is considerably wider than the top of the abacus, being about $4\frac{5}{8}$ ". Observe the stems of these leaves as they grow up over this bell-shaped top, making a series of ribs, over which some of the lower leaves lap. Draw these veins in lightly at first, arrange the overlapping leaves over them about the middle of the capital, and also similar leaves that sweep to the right and left and support the broadest part of the projecting ornament. Detail all of this carefully in outline, and then proceed with the shading.

The first shading on the abacus consists of the beveled edge of the upper member. An angular fillet is presented next with its two surfaces expressed with the shade lines only. The round member, called a *bolus* in this style of architecture, is shaded on its lower half only in order to express the curvature, care being exercised to leave a white thread-like line between that and the shading of the hollow member beneath. The hollow member is then shaded at the

top and with more pressure on the line at the top than at the bottom in order to grade the tone. This can be observed by looking at the illustration with partially closed eyes. Shade the bell of the capital in a simple even tone next; this will throw the details of the ornament into relief, and very little shading on the ornament itself will suffice to give it character. The left half of this figure remains entirely in outline in the illustration, the purpose of this being to give the student a clearer idea of the structural character of the ornament. The leaves are blocked out rather than finished in detail so that he may see what general forms to sketch in first. When the drawing is completed, however, the shading should be carried over the entire capital so as to present it as a finished whole. Letter this sheet, in the same manner as the preceding ones, with the title SHADED ORNAMENT, exercise number, sheet number, date, class letters and number, etc., and send all the sheets of the exercise to the Schools for correction.

65. These four sheets represent various forms of detail that are met with in every branch of applied design. They are all, more or less, architectural in character, but as conventionalized forms they represent a class of ornament that pervades all branches of art. Where they are included in stone, plaster, carved wood, or other relief work, they present details that must be shaded in a drawing to express them. Where executed on the flat, as for wall decoration or textile work, their variation of surface may be expressed in light and shade or color. For work of this character, shading should be applied in the most conventional manner, the intention being simply to indicate details by a few masses of high light and shadow without attempting to give a pictorial rendering such as would be required in a book illustration, or a drawing for pictorial purposes. This conventional method of rendering brings out the characteristic details of the ornament, which are important in this first work.

Where the ornament is subordinate to something else,

as it would be as part of an illustration, or a detail of an architectural design, it can be expressed with fewer lines and less attention need be given to the proportioning of individual details, as it would then blend with the whole composition and give a more satisfactory effect.

WASH WORK AND BRUSH DRAWING

EXERCISES

1. In architectural drawing, color or wash work is used in various ways to represent texture or material. The term **wash work** is used because the color is laid over the drawings in thin transparent washes that permit the pencil or ink work to show through, when desirable, after the color is laid. These washes are divided into two general classes; namely, *flat washes* and *graded washes*. **Flat washes** are used to show sectional parts of plans or details and to indicate at the same time the material through which each section is taken. Thus, we color in the wooden, stone, and brickwork walls of our plans to show their material. **Graded washes** are used to render finished drawings pictorial. They are rarely used to show sections through materials, but are applied to elevations and accessories to express material and give warmth and texture to the composition.

2. This Section will consist of four exercises executed on 9" × 12" sheets with an 8" × 11" border line. The purpose of these exercises is to train the student in handling the brush so as to lay both flat and graded washes as will be required in subsequent architectural problems. The paper on which these drawings are to be executed should be either Whatman's cold-pressed, Strathmore, or "TEC" water-color special.

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To obtain the best results on drawings where washes are required, the paper should be stretched or mounted on the board, instead of merely fastened by thumbtacks. When doing this be sure the drawing board is perfectly clean and absolutely free from greasy substance. Lay the paper "right" side up on the board. (The *right* side of any water-marked paper is that which is toward you when you can read the water mark in its proper sequence of letters. The right side of "TEC" cold-pressed paper is grained, resembling cloth; the wrong side is distinguished by minute holes or depressions.) Turn up an edge about $\frac{1}{2}$ inch wide, all around the four sides of the paper, so that the paper resembles a large flat dish or tray with a raised edge. Now reverse the paper so that the wrong side will be up, the paper resting with its folded edges (reversed) touching the board. Apply library paste, with a stiff brush, to this folded edge (so that it is on the "wrong" side of the paper) and then go quickly over the paper with a wet sponge, taking care not to touch the paste. Then reverse the paper so that the right side will be up, and smooth it from the center toward the edges with a damp sponge, pressing down the pasted edges until they are sufficiently dry to adhere to the board all around. If the edge of the paper does not adhere tightly at certain places, when the paste is still moist rub it tightly into place with a flat paper knife or even with the back of the finger nail. Lay the board flat and give the paper time to dry by evaporation. Do not try to hurry it by placing it in the heat, for this will probably cause the paste to crack loose from the drawing board. The paper will at first look wrinkled and spoiled, but will soon dry and be perfectly smooth.

EXERCISE I, TITLE: FLAT WASHES

3. Exercise I, Sheet I.—Within the border line, 8 in. $\times$ 11 in., construct four rectangles each $3\frac{1}{2}$ in. $\times$ 5 in., as shown in the accompanying diagram. In the upper right-hand rectangle, Fig. 2, draw two circles whose radii are $1\frac{1}{8}$ in. and $\frac{5}{8}$ in., respectively. Connect these two circles by

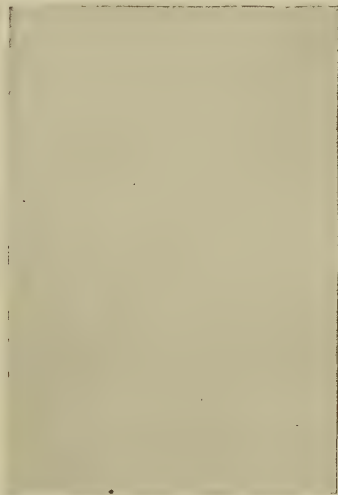


Fig. 1

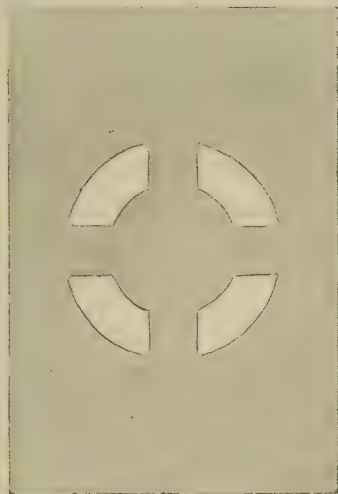


Fig. 2

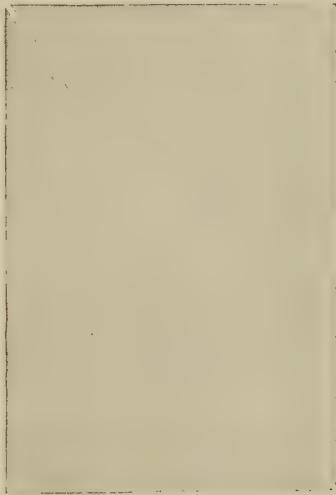


Fig. 3

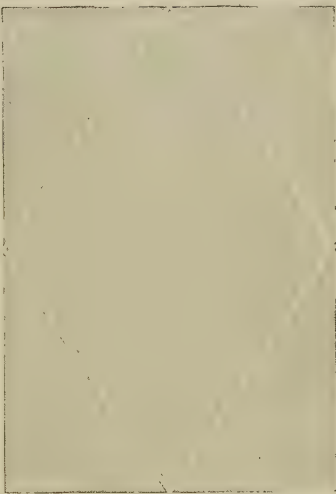


Fig. 4

$\frac{1}{2}$ -inch vertical and horizontal bars, as shown. In the lower left-hand rectangle, Fig. 3, draw two parallel diagonal lines from corner to corner about $\frac{1}{16}$ inch apart, and in Fig. 4, draw parallel diagonals $\frac{1}{16}$ inch apart from the center of each side as shown. These subdivisions should be made with a pencil not harder than HB, and all lines except those needed to limit the surfaces to be washed over should be carefully removed by the use of a soft eraser.

4. For the purpose of washing over these areas, use charcoal gray or some other water-color paint. The best tints for the latter are ivory black and sepia. In any case, mix up a considerable quantity so as to make a liberal amount of wash, as it is nearly impossible to mix up an extra quantity to exactly the shade or tint after a small quantity is made up first and becomes exhausted.

With charcoal gray, moisten the half pan or part of the contents of the tube, and mix a few brushfuls with half a glass of water. Stir it with the brush, test on a piece of scrap paper, and allow it to dry before any attempt is made to wash in the drawings. In laying washes of any color, it is best to keep them light in tone, as evenness can better be secured in a light wash than it can in a dark one. In applying the wash, the color in the glass should be constantly stirred, as the water and pigment are otherwise likely to separate and the pigment settle at the bottom, thereby making the wash uneven in places. While in general practice it is advisable to mix the color to the exact tone required and lay it on the paper, wash drawings may be varied by laying a new wash over the old one after the latter has dried, thereby deepening its tone, as will be observed as we proceed with these exercises.

5. To wash in Fig. 1, take up as much color as possible on the No. 6 brush and apply it to the upper left-hand corner of the rectangle, as shown in Fig. 1 of the text. Care should be exercised to not let the wash extend over the edges, and to have sufficient color to secure a liberal pool at the corner of the rectangle. Tilt the board so that with the aid of the

brush the color may be led to flow downwards toward the lower right-hand corner, where it should be conducted in a series of curved strokes, as shown by the dotted lines in Fig. 1 of the text. As each stroke is made, the brush should be redipped in the color and the wash carried down with a liberal supply of fluid on its lower edge. If the brush is not large enough to carry the entire pool across from the side to the corner, as from *c* to *d*, it should be carried as far as possible and redipped in the saucer; under no circumstances must the lower edge of this wash be allowed to

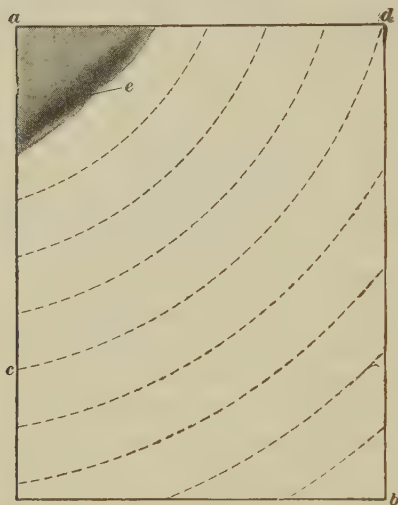


FIG. 1

become even partially dry as it proceeds across the rectangle for it will then leave a line. When the corner *b* is reached, the surplus color may be taken up with a dry brush, or with one from which the color has been extracted by drawing it across a blotter. Repeated applications of the brush to the blotter and to the corner of the rectangle will remove all the surplus fluid and leave the entire wash perfectly even and clean, as shown in Fig. 1 of

Sheet I. As the laying of flat washes of this character is a matter of practice more than skill, it will be well for the student to repeat this exercise several times before attempting the one to be sent in for correction. The sole purpose of this exercise is to train the student to lay flat washes such as are used in architectural drawing and rendering.

6. In washing in Fig. 2, the process is precisely the same as for Fig. 1, but more care is required as the wash must be led around the circle and bars in the center without going

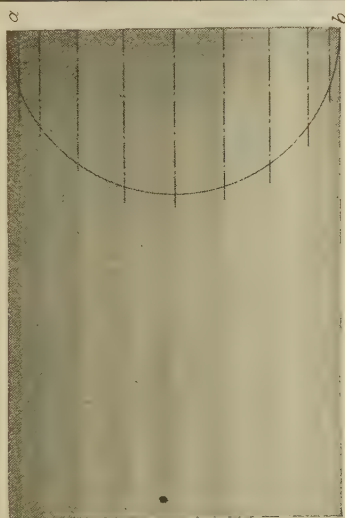


Fig. 6

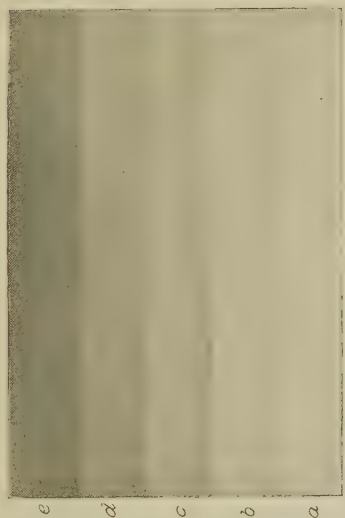


Fig. 5

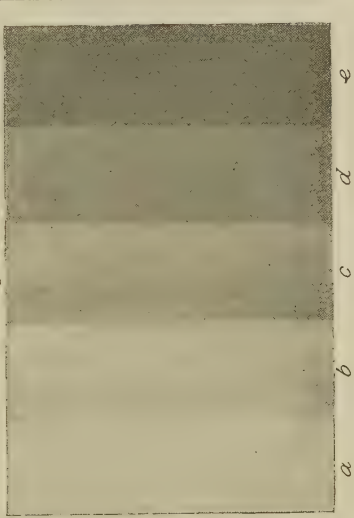


Fig. 8

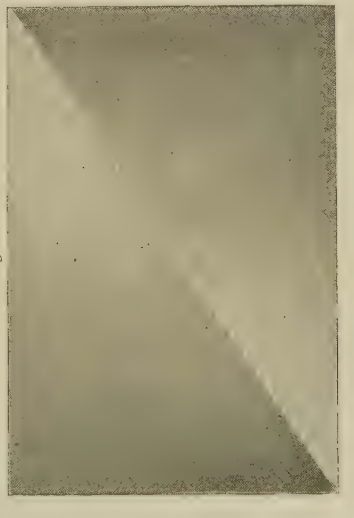


Fig. 7

over the edges. The work is commenced, as before, at the upper left-hand corner and carried across and around the outer circle so as to leave a pool of color where the wash is to be continued, but as nearly dry as possible where it finishes against the line of the center circle. The contact of the wash with the boundary line of the white segments in the center may be kept dry by means of a brush and blotting paper in the same manner as when the corner of the rectangle is finally reached and the surplus color is intended to be removed. Figs. 3 and 4 are rendered in precisely the same manner as the others, except that great care must be exercised to see that the color does not pass over the $\frac{1}{8}$ -inch space between the subdivisions, the purpose of the last three exercises being to train the hand to steadiness.

Having completed these flat washes on the four rectangles, ink in the border line, 8 in. $\times$ 11 in., trim the sheet to 9 in. $\times$ 12 in., and letter the title, FLAT WASHES, exercise number, class letters and number, etc., as heretofore. The lettering for the title and other data is to be the same as that used in *Freehand and Ornamental Drawing*. Lay this sheet aside until Sheet II is completed.

7. Exercise I, Sheet II.—The rectangles in Sheet II of this exercise are laid off as were those on Sheet I, and should be subdivided as follows: Draw through Fig. 5, four horizontal lines equally spaced, so as to divide the rectangle into five equal bands, or stripes. On the end of Fig. 6 describe a semicircle whose diameter ab will be equal to the end of the rectangle, that is, $3\frac{1}{2}$ inches. Divide the circumference of this semicircle into ten equal parts and through the points of division draw horizontal lines the full length of the rectangle, as shown. This will divide the rectangle into ten bands of varying widths in proportion to the receding arcs of the semicircle. Fig. 8 is divided similarly to Fig. 5, except that the lines of subdivision are vertical, and Fig. 7 like Fig. 3, Sheet I.

8. The graded washes in Figs. 5, 6, and 8 are laid by repetition; that is, all four rectangles are first washed over

with a plain wash, identically the same as in Fig. 1. After these are *thoroughly dry*, a second wash is laid over the rectangle with the omission of one of the subdivisions as shown, and when this is dry a third wash is laid omitting another subdivision. In this way we have, in Figs. 5 and 8, one wash at *a*, two at *b*, three at *c*, etc. In Fig. 6, the washes are graded in tone, thus presenting the appearance of a rounded or prismatic surface. The sections of the rectangle being divided at projections from the semicircle, the appearance of the curve is very marked, and to enhance this effect the washes are laid so that they grade in each direction from the lightest wash, which is on the third rectangle from the bottom, but on the dark side of the rectangle the heaviest wash is found at *a*, where there are eight applications, while below it there is one less as each subdivision is passed. The work in Fig. 7 is similar in effect to Figs. 5 and 8, but much more difficult in application.

Graded washes, as in Fig. 7, are laid by first applying the top tone on the upper edge of one of the triangles with the brush charged with very dark color. This wash is carried down about one-fourth the depth of the triangle from the edge, that is, the edge that is being worked from. The pool at the bottom of the wash remains as usual while the tip of the brush is redipped in clear water and added to lower edge of this pool so as to dilute it, and the wash is carried somewhat farther. Again the brush is dipped in water and the diluted wash is carried still farther until the bottom of the triangle is reached and the tone is almost clear water. In this way, the color grades from dark to light. The lower half of Fig. 7 is similar in appearance but reverse in effect. Here the wash is applied in its lightest tone first and additional color is added to it to deepen the tone as the pool is carried over the plate. When the lower side is reached, the darkest tone is applied. Precisely similar results can be obtained by either of these methods, but it is occasionally more convenient to use one than the other. The ability to lay graded washes of this character gives confidence to the student and trains him to understand his color and appreciate



Fig. 1.

what can be done with it. Fig. 8 is executed in precisely the same manner as Fig. 5 except that the bands are vertical.

Having completed these flat washes in the four rectangles, ink in the border line, 8 in. $\times$ 11 in., trim the sheet to 9 in. $\times$ 12 in., and letter the title, FLAT WASHES, exercise number, class letters and number, etc., as heretofore. The lettering for the title and other data is to be the same as that used in *Freehand and Ornamental Drawing*.

The two sheets of Exercise I are now mailed *flat* to the Schools for correction.

EXERCISE II, TITLE: WASH DRAWINGS

9. The rendering of this exercise, although somewhat different in method from any of the previous ones, is dependent none the less on identically the same principles.

In wash drawing, it is necessary to use several values, or tones, and it should be remembered that these values should be produced directly; that is, one wash of the proper depth of tint should be used instead of several washes laid over one another. The direct method gives a snap and crispness to the drawing that is impossible to obtain by means of a series of washes.

In wash drawing there are no outlines. In certain conventional renderings, such as Sheet I of Exercise II, the outline is inserted as a part of the design, but observe in Sheet II the entire form is expressed by a series of graded washes adjacent to one another without any individual outline being expressed. It seldom occurs that one need employ more than five values in order to express what is desired in his picture.

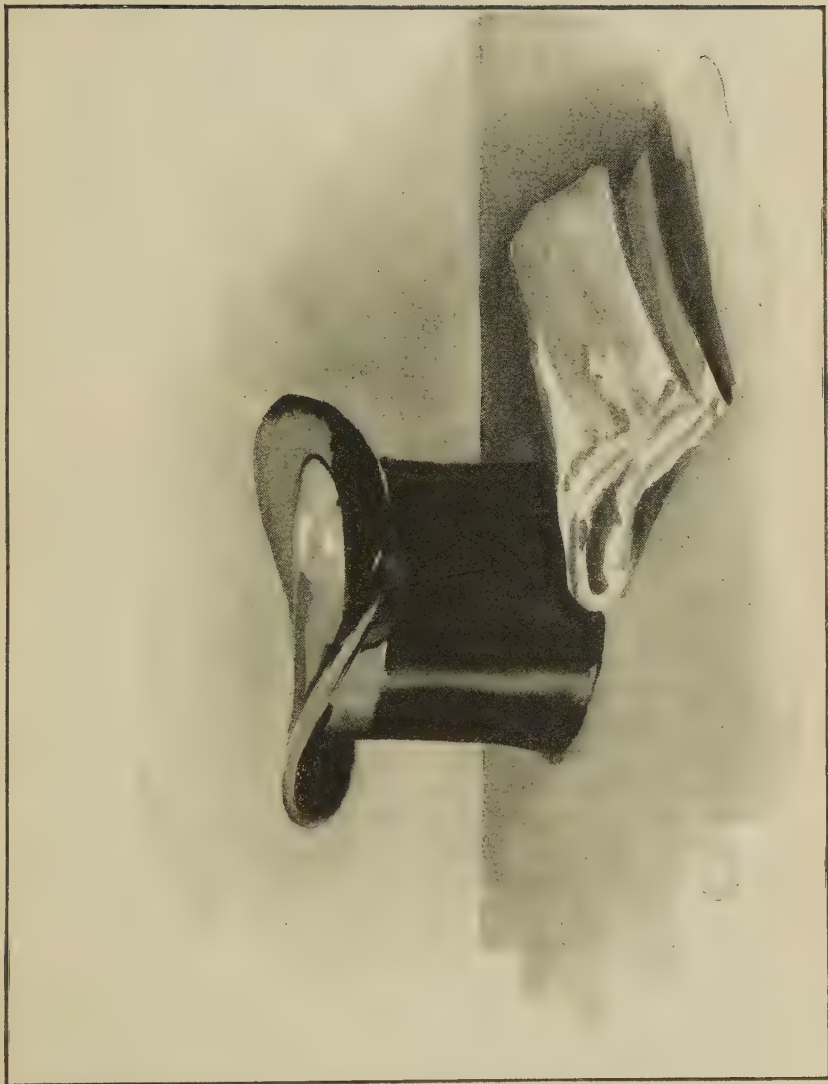
10. **Exercise II, Sheet I.**—The medium, or material, in which Sheet I is rendered is charcoal gray, although for some monochrome rendering, sepia is used, occasionally tempered with a little Vandyke brown or burnt sienna to lighten or deepen its tone. The washes for the plate may be mixed in an ordinary saucer, or a special water-color dish with several compartments. It is best to have two or three

small dishes to contain the different washes representing different values, although after the student becomes experienced and skilled in the use of the wash he will be able to mix these values readily by adding more color or more water to the solution that has already been prepared. A blotter should be close at hand in order that the brush may be quickly dried, when occasion demands it, and a small, soft, wet sponge will be found exceedingly handy for wiping off a bad wash before it gets dry.

11. To draw Sheet I, the student should make the enclosing rectangle 8 in. $\times$ 11 in. This figure indicates a simple treatment in flat tones of a still-life study, and contains five values including the white and the black. No attempt has been made to render actual light values, except where the small patches of white indicate where the strongest light falls on the objects. Observe how much can be expressed by the simple suggestion of these high lights, and study their location in still-life objects in order that they may be put in their proper places.

The best method of executing this drawing will be to make a careful drawing in pencil on another piece of paper and then carefully trace and transfer it to its proper place on the drawing sheet that is to be sent in for criticism. This is advised because, when washes are to be applied to the paper the surface must be perfectly smooth and even, and if much rubbing is done, in order to correct the drawing, the washes will not flow evenly.

The success in the rendering of this figure depends as much on the accuracy and truth of the facts as on the smoothness of the washes; truth in values can be obtained only by painstaking care, in experimenting with each wash and matching it carefully with the scale of value desired. Smooth washes can be obtained only when the wash is laid rather quickly and spread over the surface evenly before any portion has had an opportunity to dry. The board should be held in a slanting position toward the worker, and the wash begun in the upper left-hand corner and carried down from



left to right. When the wash is completed and the surplus color has reached the lower right-hand corner, the brush should be dried on the blotter and the point applied to the wash to absorb the superfluous moisture. Care must be taken on this figure that one wash is thoroughly dry before the next one is laid beside it, otherwise they may run together. Sometimes it is desirable to have them do this. The high light on the pitcher should be expressed by allowing the white paper to show, and *never* by using Chinese white. The dark outline in this figure is executed, after all the washes are dry, with the point of the brush.

The sheet should now be trimmed to 9 in. $\times$ 12 in., and the exercise number, sheet number, student's class letters and number lettered in as before.

12. Exercise II, Sheet II.—In Sheet II, the rendering will be more complicated because the expression of light and shade is added to that of the color value and the shades are graded and vignetted into one another. In applying the wash to this drawing, the principal object should be considered first; that is, the silk hat. First, lay the light gray wash inside the band, leaving the patch of white where the high light falls. When this is nearly dry, add the middle value to the rim and the ribbon and down the high light of the crown. Before this latter is quite dry, the deep black should be applied so that it will spread into it slightly and not produce a hard line where the high light and the dark portion come together. If there is a tendency for the black to spread too much, it is a sign that the half tone is too wet, and the tendency to spread may be lessened by touching it slightly with the edge of a piece of blotting paper. The rest of the crown should now be laid in, and the very slightly reflected lights on the side of the hat may be produced by absorbing with the blotter the excess of color that gives the deadness of tone. The softening of washes at the edges, where such is desirable, so that a dark tone may gradually blend into a light one, is usually effected by rinsing the brush in clear water and then gently drawing it along the edge of the still wet

wash that is to be softened. In this way a dark tint may be gradually washed down almost to pure white.

Another way of vignetting the dark tint into the light tint is to wet the paper before the dark tint is applied. Where a light gray tint is to be washed into a lighter tint, this is the better method, because the entire surface may be moistened with clear water, and then the gray tint worked into the center of it wherever desired, and the edges afterwards softened off so that no line of demarcation exists between the white paper and the gray tint.

The usual border line 8 in. $\times$ 11 in. is then drawn freehand, with the point of a fine brush, and in the medium used on the darkest tone of the hat. The proper lettering is also placed on the margin and the sheet trimmed to 9 in. $\times$ 12 in., and laid aside with Sheet I.

13. Exercise II, Sheet III.—Sheet III is a small sketch of part of one of the California Mission Buildings. The only new thing in this figure is the rendering of the foliage, which is extremely crude and suggestive. The principal object is the tower and dome, which should be drawn first. There are two shades of gray on the sides of the dome, and the windows are one tone darker. In rendering the foliage, begin with middle gray and soften it at the edges where necessary in order not to make it too harsh. The black on the poplar tree should be added while the middle gray is still moist, in order that it may spread and produce a soft effect at the edges. The slight suggestion of outline around the dome of the tower and along the eaves and string courses should be introduced in order to preserve the architectural effect of the building, in contrast to the sketchy foliage.

The freehand border line 8 in. $\times$ 11 in. is drawn as on Sheet III, and the usual lettering inserted at the proper places. The sheet is then trimmed to 9 in. $\times$ 12 in. and then laid aside with Sheets I and II.

14. Exercise II, Sheet IV.—Sheet IV is a problem in rendering similar to that on Sheet III, but slightly more





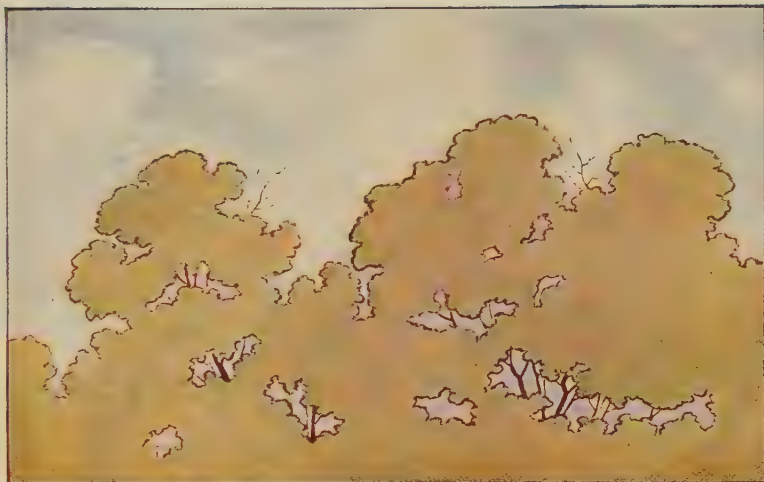


Fig 1



Fig 2



Fig 3

difficult. The two sides of the pyramids are expressed in two tones, and the other details of the landscape are rendered in tones that give them contrast and variety of effect. This problem should be studied carefully and rendered according to the principles described. There is nothing in it differing from the preceding ones, except the rendering of the water and the reflections. To render these reflections, either of two methods may be employed. First, the paper should be dampened with clean water and then the dark tones of the reflections washed in, the edges being still further softened off with a moist brush. After these are thoroughly dry, the body tone of the water should be washed over the entire space that it is to occupy, including the dark tones of the reflections previously placed. Or, second, the main body tone of the water should first be washed in and allowed to become almost dry, but not entirely so. The dark tones of the reflections should then be washed in over the moist background, the edges of the reflections blending softly into the background. This method should also be used for the clouds. These reflections must be repeatedly practiced on separate pieces of paper before the final sheet is rendered.

The inside border line should be made with a broad solid brush stroke, while the main border line 8 in. $\times$ 11 in. is drawn as before, and the usual lettering included. The four sheets of this exercise should then be mailed *flat* to the Schools for correction.

EXERCISE III, TITLE: ARCHITECTURAL TREES AND SKIES

15. Exercise III will be executed on one sheet of the usual size—9 in. $\times$ 12 in., with the border line 8 in. $\times$ 11—the three drawings taking up the entire space.

The outline of the trees in Fig. 1 should be sketched in very lightly with a soft pointed pencil, as also the openings in the foliage, as shown. Then with a wash of gamboge, to which a little new blue has been added, the space occupied by the foliage should be deliberately washed in. This wash should *not* be mixed in a saucer and applied as an **even**

wash, as was the case with Exercise I, Flat Washes, but the two colors composing it should be taken into the brush and mixed as they are spread across the paper. A variation of tone and color is thereby secured, and a degree of transparency exhibited that would be impossible if the colors were mixed thoroughly before being applied. The outlines of the foliage and the openings therein may be emphasized with the point of the brush charged with burnt sienna and the suggestion of branches also expressed. The sky is rendered by thoroughly wetting the upper part of the sheet with clear water, and while the surface is still quite damp applying new blue in light irregular washes as shown. Do not try to get absolutely flat or even washes in any of these figures. If the washes turn out flat, let them be so, but if they are mottled, do not go over them. One style is as good as the other.

In Fig. 2, the outline of trees should be lightly indicated as stated and the purple wash applied with a mixture of crimson and new blue, while the dark green wash in the foreground is made with gamboge and Prussian blue. The foliage here is made by means of a series of rapid strokes, the intention being to express an effect without absolute detail. In Fig. 3, a similar procedure is carried out, but the general foliage is drawn with gamboge and Prussian blue. The foreground is expressed by a light wash of burnt sienna and the sky is worked in on dry paper with new blue or cobalt.

In executing this exercise, it is not the intention that the student should copy. Architectural trees and skies are added to drawings in order to produce effect, and their conventional character does not require that they should be worked up in any detail. The student should bear in mind that any variation that can be made from the examples sent him will be to his advantage, and the exercises sent in for criticism and correction should be the exercises of his ingenuity and originality, as well as of his skill with the brush, and not a copy.

This sheet, Exercise III, should be lettered as usual, trimmed to 9 in. $\times$ 12 in., and mailed to the Schools *flat* for correction.



Date

Time consumed in
executing this sheet

Name of Student, Class Letters
and Number I L T 53D § 4

ELEMENTARY PERSPECTIVE DRAWING

INTRODUCTION

Five Drawing Exercises in this Section are to be prepared and submitted for examination, but only after all the text instructions have been carefully studied and understood. Directions for preparing these Exercises are given on pages 102, 103, and 104.

1. Translating Plans Into Pictorial Drawings.—So far, training has been given in the making of plan and elevation drawings that show the builders how, and of what materials, to build the structure. Such drawings, while perfectly intelligible to the builders, become a meaningless mass of lines when submitted to a client. What the client wants to see is a picture of the proposed building as it will appear when completed. A photograph of the building would meet the requirements, but, obviously, no photograph can be taken of a building that has not yet been erected.

It is the work of the architectural draftsman to convey to the client or house owner a clear and intelligent idea of how the structure will appear, and he must, therefore, translate the plan and elevation drawings into a drawing that will show the house as seen in three dimensions (width, height, and depth), and this must be done on a sheet of paper having only two dimensions (width and height), the result being what is known as a **perspective drawing**.

2. The Principle of a Perspective Drawing.—The principle of making a perspective drawing is shown in Fig. 1.

Here the man, as he stands and looks through the window pane, sees the retreating street with houses on each side, which view has width, height, and depth. But every portion of this scene is projected onto the window pane, just as it would be projected onto the ground glass of a camera. He can, therefore, with wax crayon or with brush and paint, draw on the surface

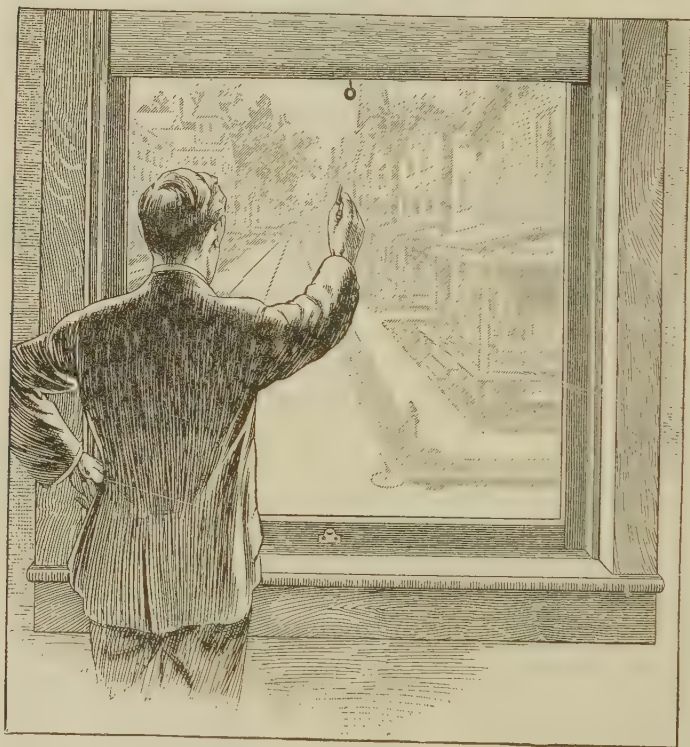


FIG. 1

of the window pane the lines in the scene, making the drawn lines and the actual lines of the scene coincide on the glass as he sees them.

This is, in reality, making a perspective drawing, but, when the architectural draftsman makes his perspective drawings, it is done on drawing paper according to certain definite principles.

PRINCIPLES OF PERSPECTIVE

RELATION OF SIZE TO DISTANCE

3. The relative sizes of the parts of an object, as expressed on the picture plane, are dependent on simple mathematical rules that determine the apparent sizes of different objects, according to their distances from the eye.

Referring to Fig. 2, if it is assumed that lines are drawn from each side of the sphere bc to the eye at e , and that these lines are intercepted by a transparent plane, as shown at $afgh$, the circular outline connecting the points $b'c'$ where the lines eb and ec pass through the plane $afgh$ will form, on this

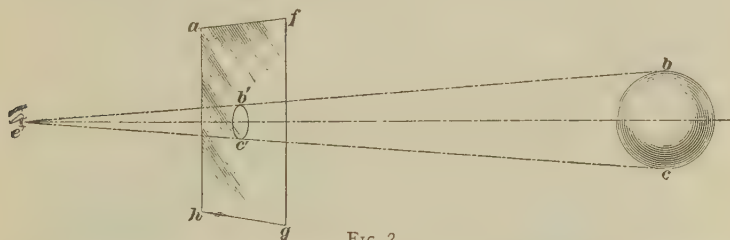


FIG. 2

intercepting plane, an outline of the sphere bc ; but this outline varies in size, according to the distances that the plane $afgh$ and the sphere bc are from the eye.

4. From the foregoing, it will be seen that the nearer an object is to the eye, the larger it will appear on the picture plane, as is shown in Fig. 3, where ab and cd are sides of two rectangles and are of the same length, but their apparent sizes on the picture plane $fghj$, as viewed by the eye at e , are different; the line cd , being nearer the eye, appearing larger, as shown at $c'd'$. From this, the following rules may be deduced:

Rule I.—*The length of any line seen on the picture plane varies inversely as the distance of that line from the eye.*

Rule II.—*The area of any surface on the picture plane varies inversely as the square of its distance from the eye.*

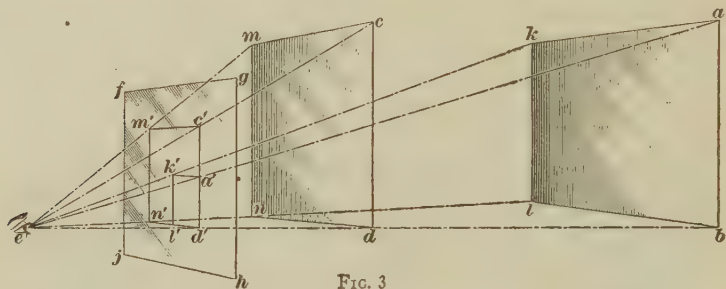


FIG. 3

Thus, in Fig. 3, ab being double the distance from e that cd is, appears only one-half the size of $c'd'$ on the picture plane $fghj$, as shown at $a'd'$; and the area of the rectangle $ablk$ appears on the picture plane only one-fourth the area of the rectangle $c'd'n'm'$, as shown at $a'd'l'k'$, as each of



FIG. 4

its dimensions is apparently reduced one-half. If the distance eb were four times the distance ed , $a'd'$ would then

appear only one-fourth $c'd'$, and the area $a'd'l'k'$ would then be but one-sixteenth the area $c'd'n'm'$.

5. Figs. 4 and 5, views down the center of a straight railway track, illustrate the fact that the rails, telegraph wires, fence rails, etc., appear to converge and meet at a point in the distance, and the apparent width of the track appears to diminish as it recedes into the distance. Fig. 4 shows the scene

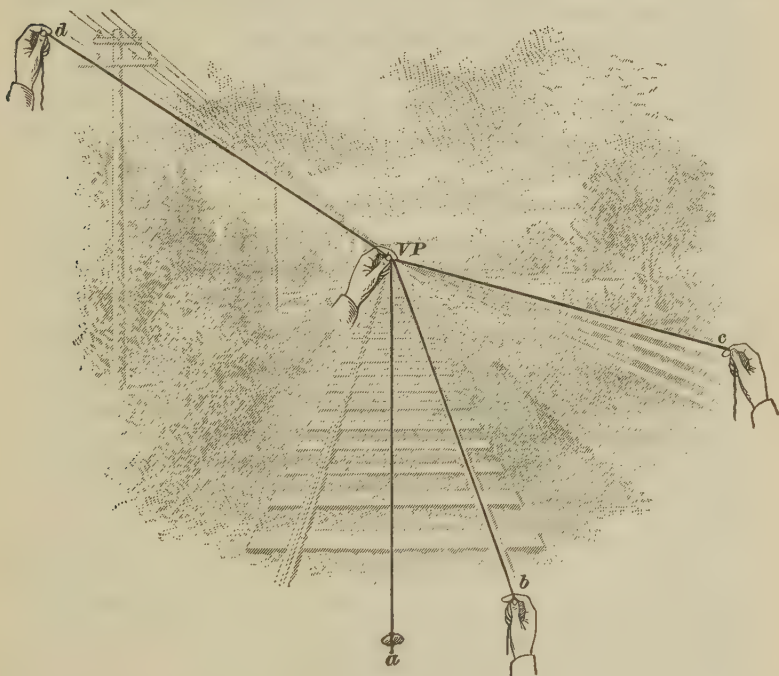


FIG. 5

as it appears to the observer, and Fig. 5 shows how one can demonstrate for oneself that the rails, wires, fence, etc. do vanish at a point, and just where this point is.

6. Hold a weighted string level with the eye and at arm's length. If the hand holding the string (viewed with but one eye open) is at the point where the rails of the track appear to meet, the hanging string will take the vertical position shown by VPa , Fig. 5. If the weighted end is now moved a little to

the right the string will coincide with and cover the right-hand rail of the track, as shown at VPb . Similarly, other vanishing details may be "covered," thus showing that they all actually vanish at the point VP .

APPARENT CONVERGENCE OF PARALLEL LINES

7. Horizontal lines that are parallel with the picture plane always appear parallel in perspective, as shown by the ties of the railroad track, Fig. 4, which appear to diminish in length and in distance apart, but remain parallel with each other, until they disappear in the distance. The same is observable in the telegraph poles and fence posts. Hence, the following rules are deduced:

Rule I.—1. *All lines parallel with the picture plane, whether vertical, horizontal, or inclined to the ground line, retain their normal directions in perspective drawing.*

2. *All lines or surfaces of objects in contact with the picture plane appear their full normal size in perspective drawing.*

3. *All lines or surfaces of objects beyond the picture plane appear smaller than normal in perspective drawing.*

4. *All lines or surfaces beyond the picture plane and parallel with it can be drawn to the same scale; but smaller than those in contact with the picture plane.*

Rule II.—1. *All lines not parallel with the picture plane, but parallel with one another, appear to converge as they recede from the eye. The point toward which any set of parallel lines converges is called their vanishing point.*

2. *When the parallel lines are perpendicular to the picture plane (as the rails, telegraph wires, and fence boards in Fig. 4), the vanishing point is directly in front of and on a level with the eye; in this position it corresponds with the center of vision.*

Hence, lines perpendicular to the picture plane and below the level of the eye slant upwards, as shown by the rails, and lines above the level of the eye slant downwards, as shown by the telegraph wires.

will be the vanishing points of 45° lines, and C will be the vanishing point of perpendicular lines. If the angles CSR and CSL are bisected, and the bisecting lines are carried to the horizon, the points l and r will be located. These are the vanishing points of these bisecting lines. In the same manner, the location of the vanishing point of any other line might be determined if wanted. AB is a line parallel with the horizon and would have no vanishing point in the picture plane; therefore, it would be parallel with the horizon in perspective.

Now, if this same triangle were drawn in perspective, no matter what its position to the right or left of the center of vision, these same lines would vanish in the same points enumerated in the horizon, as shown in Fig. 7, where at (*a*) the perspective view of the triangle is shown below the horizon and to the left of the center, at (*b*) above the horizon and to the right of the center, and at (*c*) below and in the center.

9. It will be observed that the closer the perspective view of the triangle approaches the horizon, the less of its surface is seen. When the view is exactly on the horizon, only its edge can be seen. Above the horizon its under side is visible, and below the horizon the upper side is seen.

With the location of these points on the horizon, the vanishing points of all the sides and two diagonals of a square or an octagon, as shown in Fig. 8, are had, which are very important details, as will be shown hereafter. However, the points r and l are not regularly used as vanishing points, but as points by which measurements of receding lines may be obtained; therefore, they are termed **measuring points**.

Now, in Fig. 6, the distances Sc and Sa are laid off on the triangle and on the line AB , and the line ae is drawn making aeS an isosceles triangle. SLl is also an isosceles triangle, and the lines Ll and aS are parallel; therefore, the lines ae and Sl are parallel.

In perspective all parallel lines vanish at the same point. Therefore, if the length of the side of the triangle is

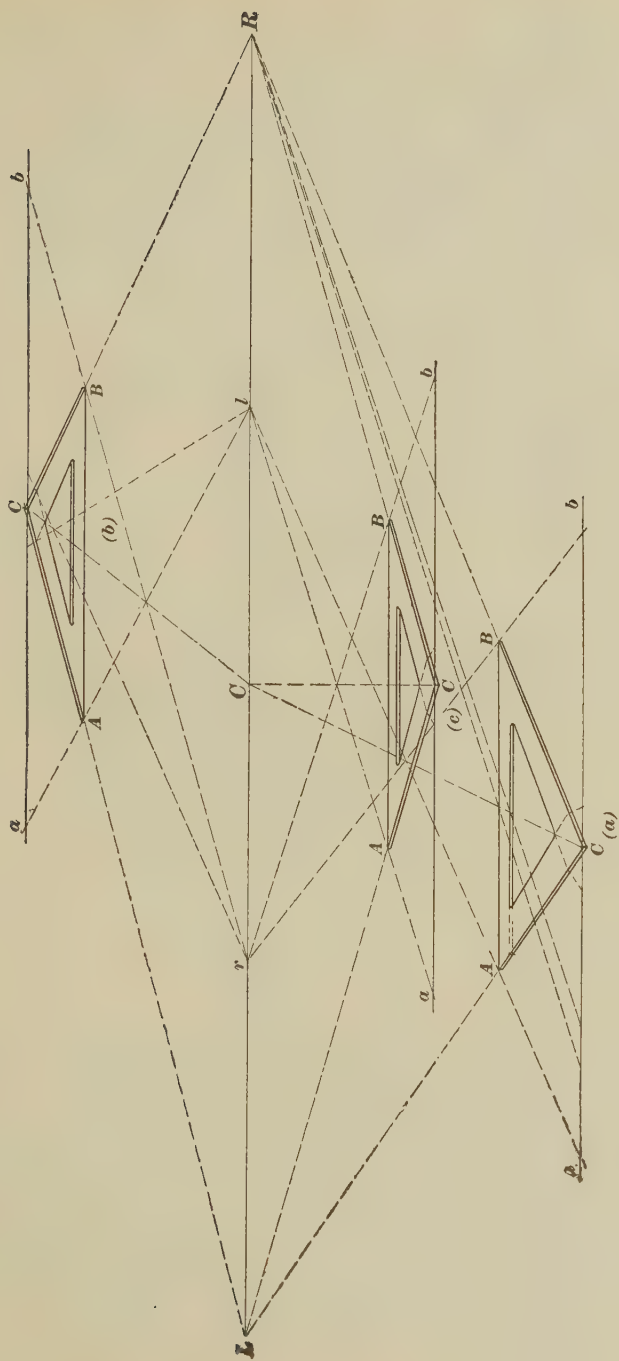


FIG. 7

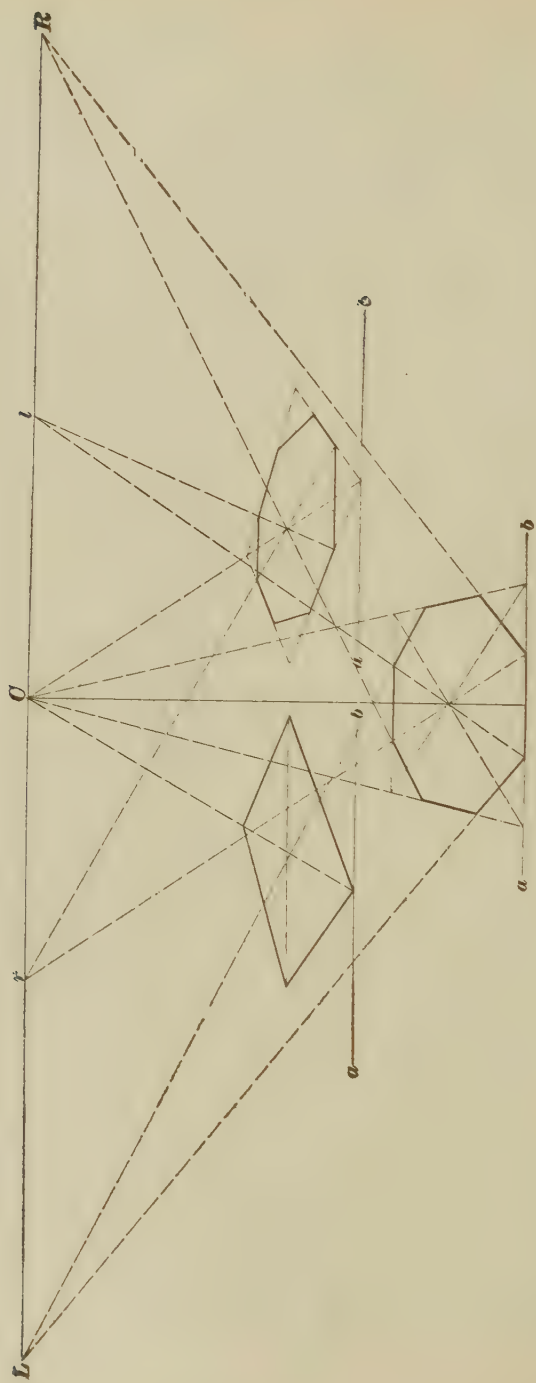


FIG. 8

laid off from C to a , Fig 7 (a), it can be transferred to the perspective drawing by projecting a line to l to cut the vanishing side of the triangle at A . In this same manner any dimensions can be determined on lines from C to L and R by projecting them from the measuring line toward l and r .

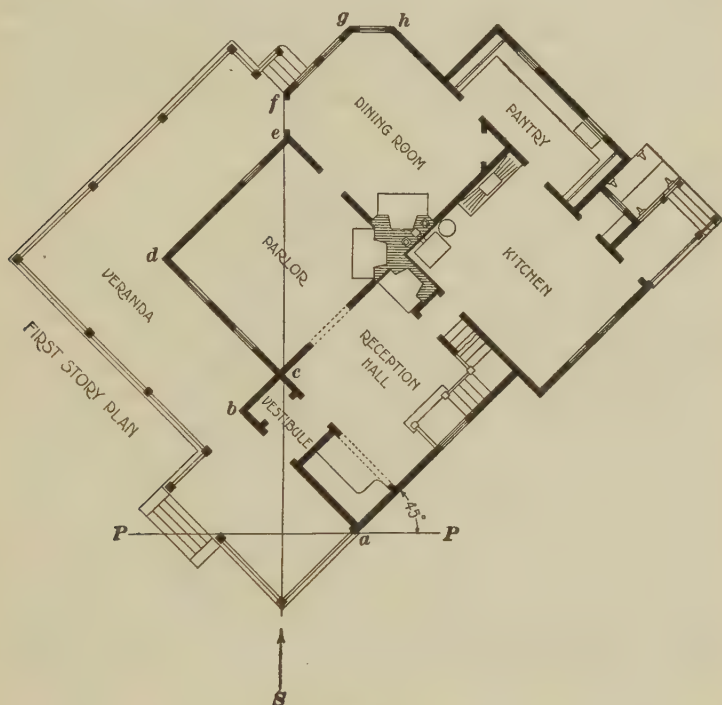


FIG. 9

10. In Fig. 9 is shown a plan of a small house, the corner of which a is in contact with the line PP , PP representing the plan of the picture plane on which this plan in perspective is about to be represented. The angle between the house line and the line PP is 45° . Then, one side of the bay window fe will be perpendicular to PP , and the other side gh will be parallel with PP . All the other main lines of the building will be at an angle of 45° with PP .

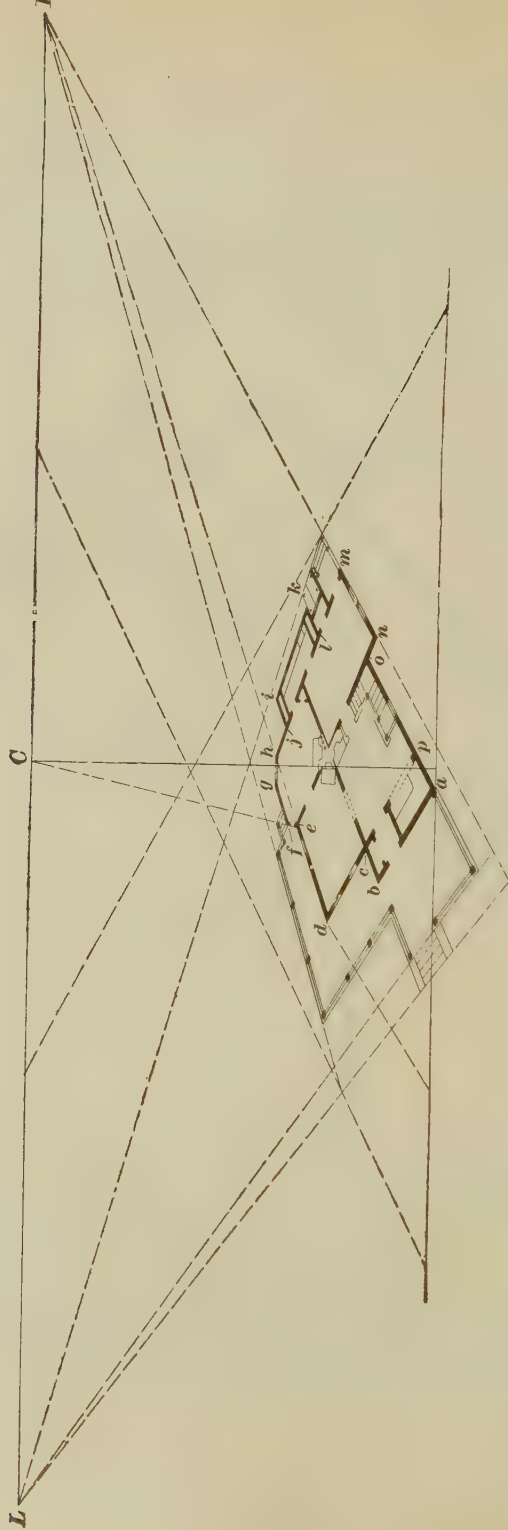


FIG. 10

Now, in Fig. 10 are shown the horizon and three principal vanishing points; f_e , which is perpendicular to the picture plane in Fig. 9, must therefore vanish at C in Fig. 10, as all lines perpendicular to the picture plane vanish at C ; and g_h , which is parallel with the picture plane in Fig. 9, is parallel with the horizon in Fig. 10, as all horizontal lines, parallel with the picture plane, are parallel with the horizon in that picture plane. All other lines in the plane are at an angle of 45° with the picture plane, and therefore vanish at L and R .

11. In Fig. 11 is again shown the illustration of the 45° triangle, with the plan of the small house laid out on its right angle. The line AB is drawn parallel with LR . The corner of the house corresponds with the angle S of the triangle. Now, if l and r are located on the line LR so that Ll and Rr are equal to LS and RS , respectively, the plan may be laid out as follows: On AB lay off $Sa_1 = 17' 0''$ and $a_1b_1 = 15' 0''$. Then, draw a_1e and b_1h parallel with Sl ; where these lines intersect SL they will lay off the distances Se and Sh exactly equal to Sa_1 and Sb_1 . In the same manner, Sc_1 is laid off to the right $= 16' 0''$ and $c_1d_1 = 16' 0''$, and the lines c_1c and d_1p are drawn parallel with Sr , locating the points c and p on the line SR . Now, Sf_1 is laid off $3' 0''$ to the left of S , and a line drawn through f_1 parallel with Sr locates z on the line RS prolonged. A line from z parallel with SL marks the side of the house at fg ; hg is perpendicular to and ef is parallel with AB .

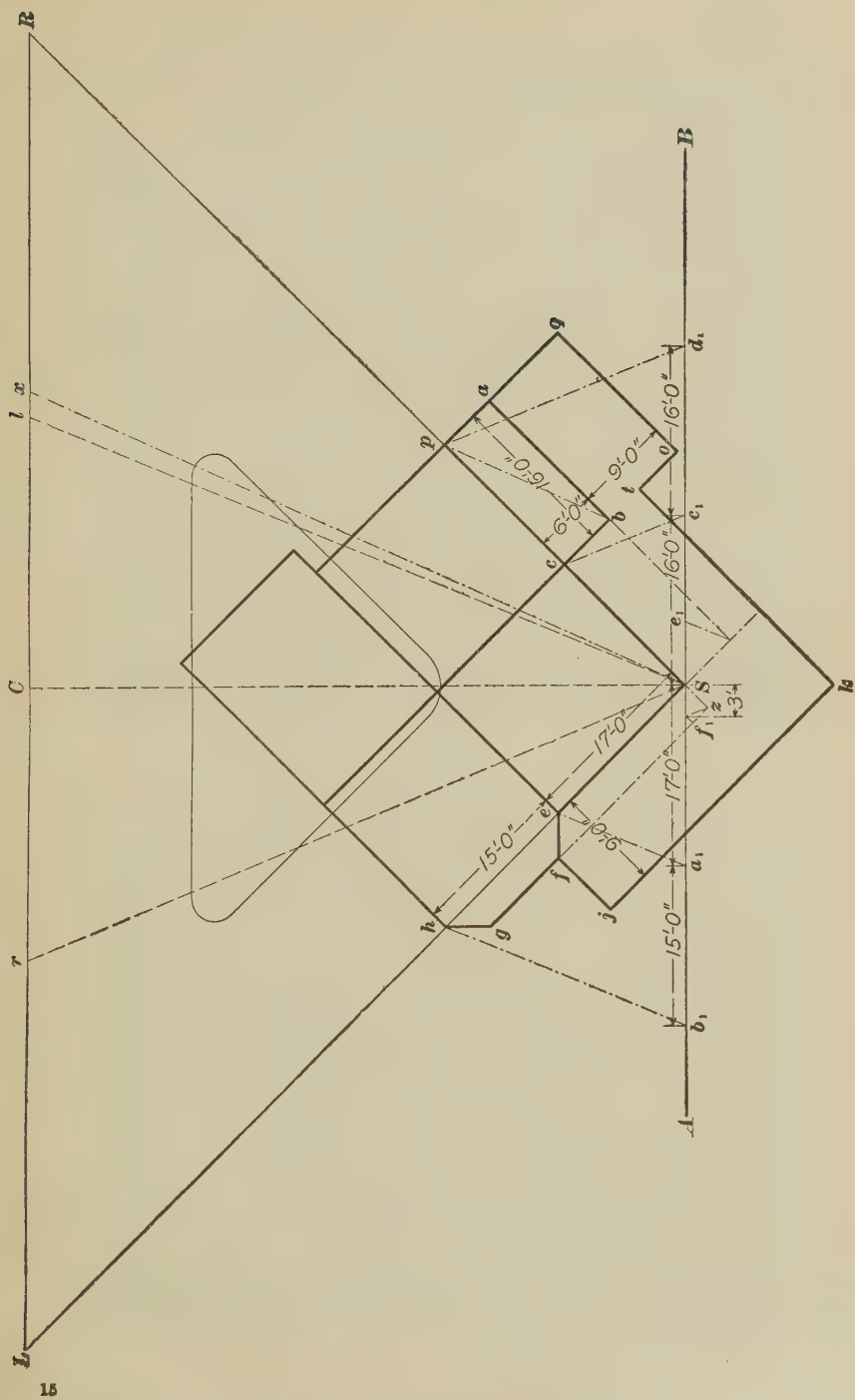
12. Now, this is all in simple projection where each line can be scaled for its actual length, but if the triangle itself is put in perspective, as was done in Fig. 7, these measurements and their relative positions can still be maintained by carefully considering the changed conditions.

In Fig. 12, the dotted outline shows the 45° triangle tipped up so that it is foreshortened, or in perspective. The side LR in this case remains unchanged, and points L, r, C, l , and R retain their relative positions. AB is drawn

through S parallel with LR . Now, if $Sa_1 = 17' 0''$ and $a_1b_1 = 15' 0''$ are laid off on AB precisely as in Fig. 11, their equivalent can be fixed on SL by drawing lines from them toward l until these lines intersect with SL at e and h . In Fig. 11, a_1e and b_1h were drawn parallel with Sl . But as parallel lines vanish toward the same point in perspective, a_1e and b_1h will vanish toward l in Fig. 12, as they are parallel with Sl .

In the same manner, Sc_1 and Sd_1 can be set off on AB to the right of S , each equal to $16' 0''$, and lines from c_1 and d_1 drawn toward r will indicate the perspective equivalent of these distances on SR at c and p , as shown. Sf_1 is set off from S $3' 0''$, and rf_1 is drawn until it intersects RS prolonged at z . A line, therefore, from z toward L will show the projection of the bay window fg in perspective. The projection of cb can be similarly shown by laying off $Se_1 = 6' 0''$ to the right of S , and drawing a line from l through e_1 until it intersects SL prolonged below AB . A line from this point toward R will then locate the side ba . The line of the veranda $jk t$ can similarly be determined by laying off its width $9' 0''$ from S to m and drawing rn through m until it intersects with RS prolonged below AB . Lk is then drawn through the point n until it meets the 45° line Ck , and the return from k is drawn toward R until it intersects cb prolonged at t . The point o_1 is $15' 0''$ to the right of S , as o in Fig. 11 is $15' 0''$ from the line SR . A line drawn from l through o_1 , Fig. 12, until it meets LS prolonged marks at p , the point from which the side oq can be drawn toward R .

13. It should be carefully noted that the measuring points l and r are used exclusively to obtain equivalent dimensions on the lines SL and SR , and that all dimensions are first laid off on SL and SR before they are carried to some other line. Also, when the dimensions are to the right, that is, on the line SR , the measuring point used is r , and when the dimensions are to the left, on the line SL , the measuring lines are toward l . This is true whether the measurement is on SL or SR above AB , or on one of these lines prolonged below AB .



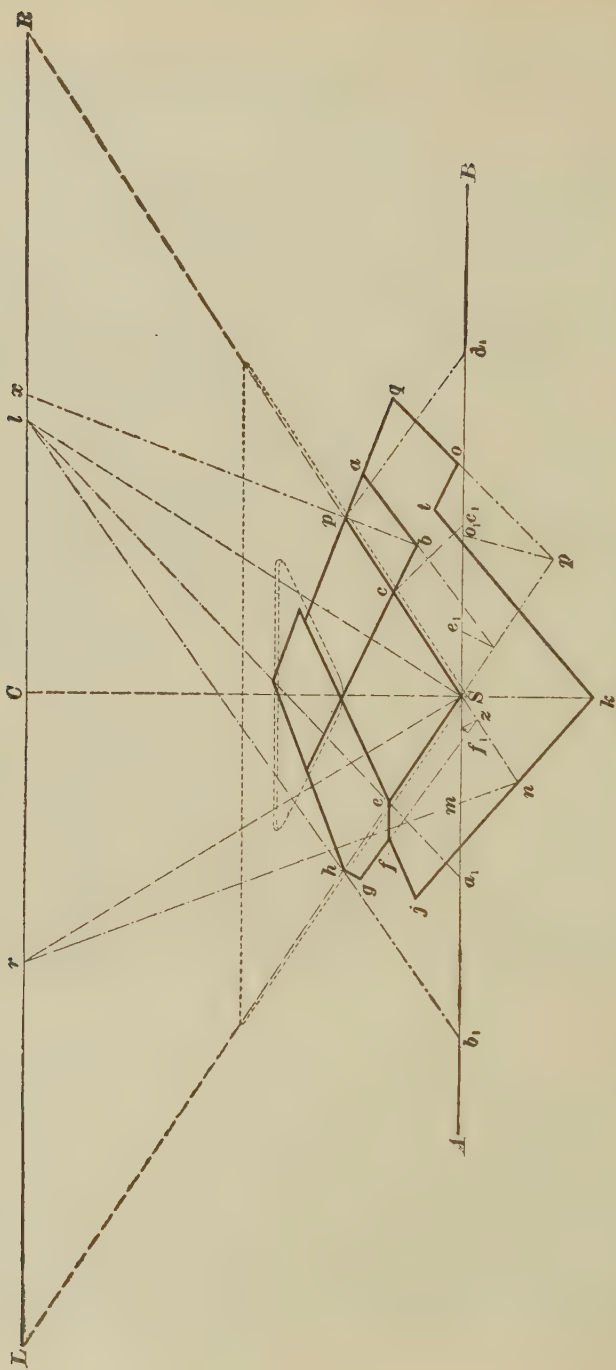


FIG. 12

Now, it has been pointed out that lines parallel with the horizon are parallel in perspective; therefore, fe will be parallel with LR in Fig. 12 as it was in Fig. 11. Also, lines perpendicular to the horizon vanish at C ; therefore, gh in Fig. 12 will vanish at C , as shown. Thus, the position of the vanishing point of any line in Fig. 12 can be found by drawing through S , Fig. 11, a line parallel with the desired line, and noting where this parallel line intersects LR . For example, suppose it were desired to locate the vanishing point of the diagonal line bp in Fig. 12. It would be necessary only to draw through S , Fig. 11, a line parallel with bp intersecting LR , as at x ; x would then be the vanishing point of bp . Now, if x is located on LR , Fig. 12, the line bp will vanish at that point, as shown by the dotted line. From this it will be seen that the drawing of a plan in perspective is quite as simple as the drawing of it in simple projection, and with the plan once drawn out, the perspective of the elevations may be constructed over the plan by projecting all horizontal lines to their proper vanishing points.

NOTATIONS FOR POINTS, LINES, ETC.

14. Vanishing and Measuring Points and Lines.

The various elements in a perspective view, some of which must be designated in a perspective drawing, such as the *station point*, *vanishing points*, *vanishing lines*, *measuring points*, *measuring lines*, etc., have already been defined. There must be, however, a uniform system of notation by letters for each one of these lines and points in a drawing, so that they will always be recognized and so that no confusion will result. A convenient system is that given below.

The **station point**, or point from which the entire scene is viewed, is usually designated by S , which is, of course, a distance below the horizon line one-half the distance apart of the vanishing points.

The various **vanishing points** are designated as follows: The central vanishing point, as VP in Fig. 5, is designated by V^o . See Figs. 13, 14, etc.

The point on the left toward which vanish oblique lines retreating toward the left is marked V^L . See Figs. 13, 14, 15, etc.

The point on the right toward which vanish oblique lines retreating toward the right is marked V^R . See Figs. 13, 14, 15, etc.

When lines of inclined planes vanish toward the left, but at points somewhere above or below the horizon, they are designated as V^N . Sometimes it is necessary to use $V^{N'}$, V^{N^2} , V^{N^3} , etc. See Figs. 27 and 28.

When lines of inclined planes vanish toward the right, but at points somewhere above or below the horizon, they are designated as V^M . Sometimes it is necessary to use $V^{M'}$, V^{M^2} , V^{M^3} , etc. See Figs. 27, 28, and 29.

Vanishing points V^P and V^Q are brought into play for vanishing lines of roof valleys, etc., in perspectives of inclined planes, as shown in Figs. 27 and 28, in connection with which further explanations are given.

Vanishing lines are designated by using the letter indicating the start of the line combined with the letters of its vanishing point. Thus (see Fig. 15) if the nearest corner of a house plan in perspective is S , the vanishing line of the right side of the house would be SV^R .

Measuring points are designated as follows: The measuring point to the left of center, used for plotting measurements on all lines extending toward the *right*, is marked M^R . See Figs. 13 and 14.

The measuring point to the right of center, used for plotting measurements on all lines extending toward the *left*, is marked M^L . See Figs. 13 and 14.

Measuring lines are variously designated. The horizontal measuring line is sometimes designated PP (when it is the bottom edge of the picture plane), and sometimes mm , ab , etc., at the convenience of the draftsman.

The vertical measuring line is usually placed in contact with the nearest vertical edge of the object or the nearest corner of the house plan. In Fig. 14 the principle of the vertical measuring line is very graphically shown by the vertical scale rules.

ANGULAR PERSPECTIVE

15. Various Classes of Perspective.—Objects, such as houses for example, may be viewed in various ways, and from different positions, thus causing the angles at which they are viewed to differ.

For instance, the observer may be viewing the house so that he will be looking at the nearest corner, in which case he will see two sides of the house; that is, the front and one end. In this view all upright lines will be vertical, but the foundation lines on the front and the side, and the upper and lower edges of the windows, seem to extend backwards from the observer's eye at different angles, and toward certain common points. An object so viewed is said to be in **angular perspective**.

Under the head of angular perspective is also usually considered **oblique perspective**, or the perspective of **inclined planes**, and it will be under the latter head that this class of perspective will here be discussed. In the case of oblique perspective, or perspective of inclined planes, the observer when viewing the house or other object concentrates his attention upon the sloping surfaces, such as roofs, gables, etc., and notices that they do not retreat toward some point or points on the horizon, but toward points above or below the horizon.

If the observer is viewing a house from directly in front, so that he is looking right at the vertical center line of the front of the house, and sees only the front elevation, and neither of the sides, the house is said to be seen in **parallel perspective**. In this case the foundation line, the upper and lower edges of windows, etc., are horizontal lines, and incline neither to the right nor to the left. If the object is small, as a box, the observer sees also the retreating top whose side edges will extend backwards toward a common point. The term parallel perspective is applied to a drawing of an object seen in this way because many of the lines in the object are parallel to the face plane of the observer, and therefore parallel to one another. This class of perspective, as well as **bird's-eye views** and the **perspective of circles**, will be discussed later.

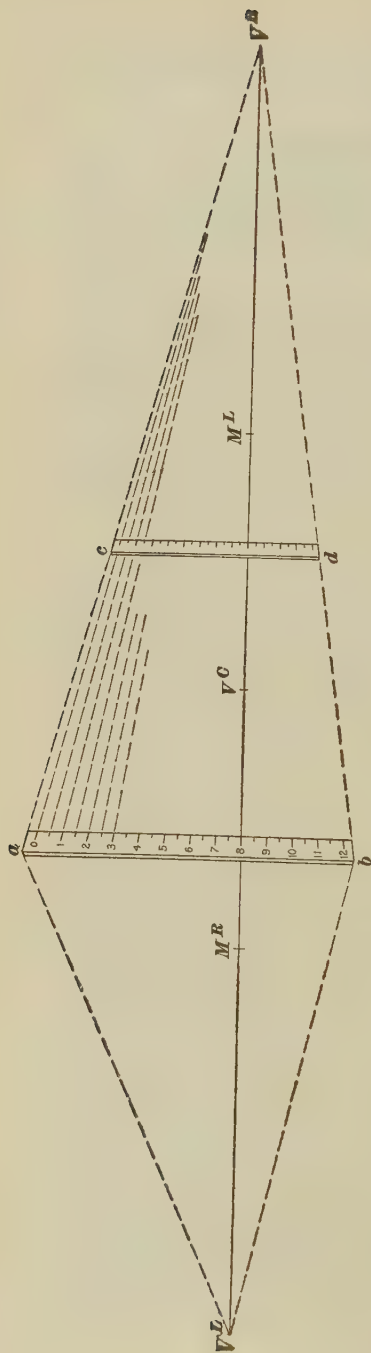


FIG. 13

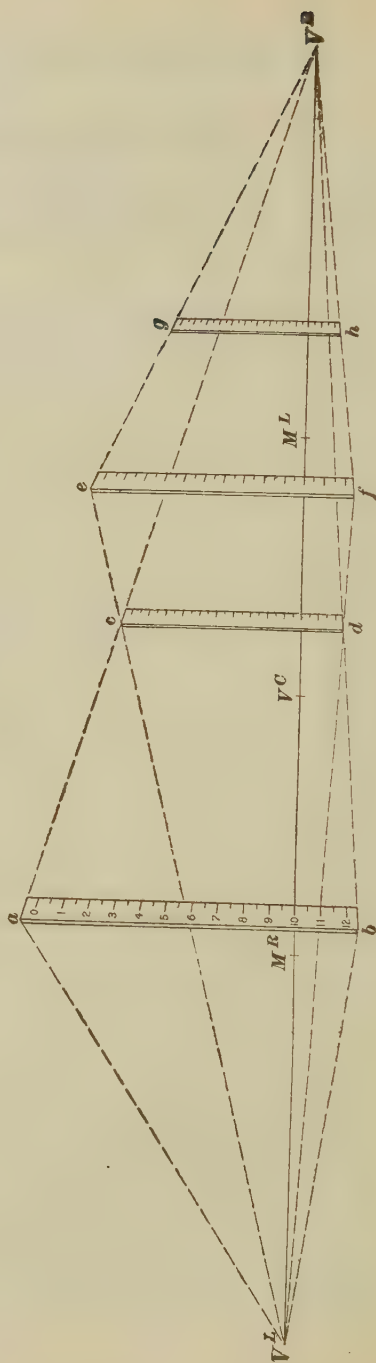
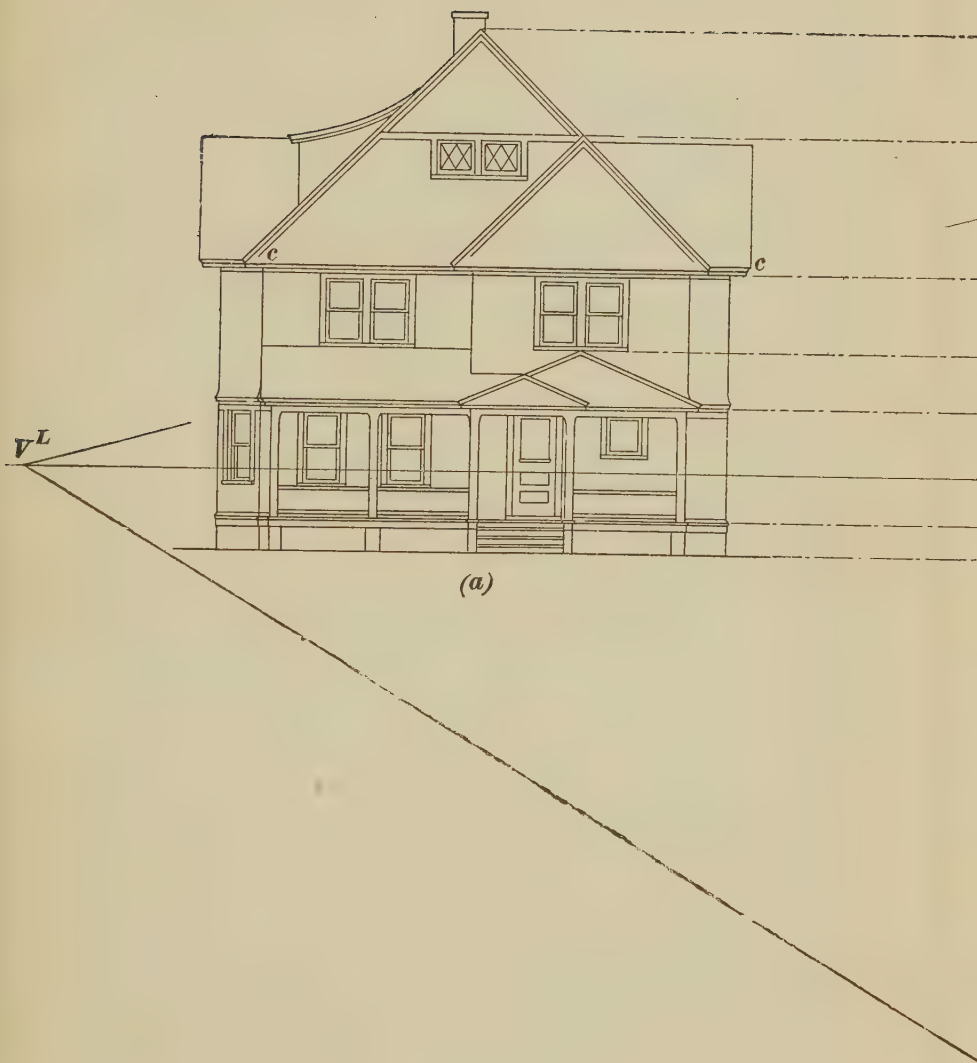


FIG. 14





SUBDIVISION OF VERTICAL LINES

16. The subdivision of the vertical elements so as to represent them in perspective, drawn to scale, is a very simple matter, as the direct proportion between vertical heights can be determined at any desired point by drawing lines toward the vanishing points. In Fig. 13 is shown an ordinary 12-inch scale; one view ab is near the eye, while the other view cd is somewhat more distant. Vanishing lines drawn from the points of subdivision on ab toward V^R establish the points of subdivision on the more distant view cd ; and although from this drawing there is no direct method of determining how far cd is away from ab , it is evident that the direct proportions of the subdivisions can be found for any distance.

Now, in Fig. 14, this point is carried further. The 12-inch scale is shown at ab . Lines drawn from it toward V^R determine the perspective length of that scale cd , while lines drawn from V^L through points c and d determine the size of the scale at ef , and lines drawn from e and f toward V^R again determine the view at gh . It is evident that drawing lines from ab directly to V^R will not give the proportions of gh , because the view gh is not on the line bV^R , and the proportion must therefore be projected from ab to cd , then back from cd to ef , and then from ef to gh . This is particularly important in locating details on perspective views of houses or other objects.

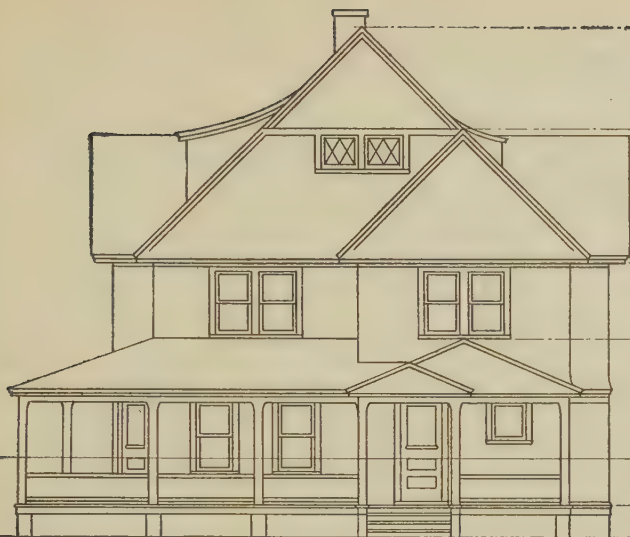
In Fig. 15 (a) is shown the elevation of a house, while a portion of the perspective plan similar to that in Fig. 12 is shown at (b), and the perspective elevation is drawn at (c). The principal corners of the house shown in the plan (b) are carried up and expressed in the perspective elevation by vertical lines, and the lengths of these vertical lines in the perspective elevation (c) are determined from the elevation (a). For instance, in the plan (b), the side of the house sc is carried up and exists in the elevation somewhere between the lines sa_1 and ca_2 . The vertical limitations of these lines are determined by projecting from the elevation (a) horizontal lines to mark

the various heights on the measuring line $s s_1$. The point of the gable in the elevation (a) is expressed on the measuring line $s s_1$ at a_1 , and a line drawn from here to V^R intersects the line $c a_2$ at a_2 , establishing the perspective point of the gable at a_2 . The eaves of the roof shown at c in the elevation (a) are measured off on the line $s s_1$ at c_1 . The measuring line $s s_1$ coinciding with the corner of the house makes it unnecessary to project the distance to some other portion of the elevation, as it can be laid off in full scale. The height of this eave line is carried across the front of the building from c_1 to c_2 in the elevation (c), and then on a line drawn from V^L through c_2 is carried to c_3 , and from c_3 on a line drawn toward V^R to c_4 in precisely the same manner that measurements were projected from the scale in Fig. 14. The distance the eave line is carried from c_1 to c_2 is determined by lines projected from s and c in the plan (b), and from c_2 to c_3 is limited by lines drawn from c and b in the plan (b), while lines drawn from b and a determine the limitations of the line from c_3 to c_4 .

Only one elevation of the house is here shown, but the other elevation can be equally well drawn by projecting its vertical distances to the measuring line $s s_1$ and its horizontal distances from the other side of the plan, as shown in Fig. 16.

Although the two elevations are in this case drawn each side of the perspective elevation, and their vertical measurements projected to the measuring line $s s_1$, in general practice this is not necessary, as the vertical distances can be scaled from the elevations on other pieces of paper and transferred to the measuring line $s s_1$, so that their proportions may be secured in their proper places. Here, then, are given the means of locating the size, appearance, and proportion of any surface in any direction by securing a perspective plan of same, as in Fig. 12, and building the elevations over the plans, as in Figs. 15 and 16.

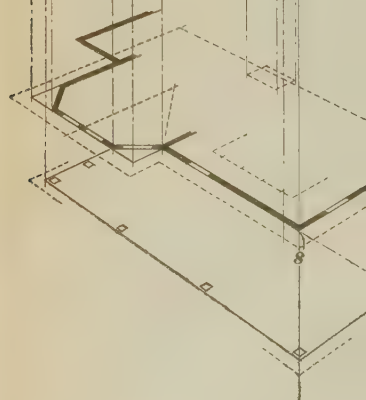
17. A Test Problem for Practice.—The serious student, who wants to get the greatest possible benefit from his studies, will want to make—for his own further practice—a perspective drawing of a building, following the principles shown in Fig. 16. It would be best, however, to make the



Front Elevation



Perspective Elevation





Side Elevation

attempt with a simpler plan and elevation, such as those shown in Figs. 17 and 18.

To make this perspective drawing, proceed as follows, but, when the drawing is completed, do *not* send it to the Schools. The only drawings to be submitted to the Schools are those called for under the head of Drawing Exercises, at the end of this Section.

On a 20"×15" sheet of paper lay out the horizon line, about 4 inches below the top edge of the sheet, and about 20 inches long, thus making V^L and V^R 20 inches apart. Point V^C will then be in the center, and M^L and M^R 4 inches on each side of V^C . Next draw the vertical measuring line through V^C , corresponding to $s\ x$, Fig. 16. Since a scale of $\frac{1}{4}$ inch = 1 foot is to be used in this drawing, the ground line should be drawn $5\frac{1}{2}$ feet to scale ($1\frac{3}{8}$ inches, actually) below the horizon. Lay out, on the ends of this line, the front and side elevations shown in Figs. 17 and 18, all vertical measurements being secured from Fig. 17. Next, the plan shown in Fig. 18 should be drawn somewhere at the bottom of the sheet, beneath one of the elevations, the total front width of the plan of the lower step being 12 feet 4 inches (to scale).

Next, start the drawing of the perspective plan so that the corner a , Fig. 18, will be on the vertical measuring line and 5 or 6 inches, actual measurement, below the horizon line. Lines vanishing back from corner a to V^L and V^R will indicate the directions of the sides of the plan in perspective. The *perspective lengths* of these sides are determined thus: Lay off the actual measurements, given in Fig. 18, to the left and right of a , on the horizontal measuring line, and from the points thus obtained carry lines back toward M^L and M^R to cut the lines from a to V^L and V^R , thus locating the perspective measurements, and completing the plan, as in the case of the plans in Figs. 10, 12, and 16.

Having completed the perspective plan, project its horizontal measurements up vertically to start the perspective elevation. The vertical measurements can be carried across from the elevations (at the sides) to the vertical measuring line in the manner shown in Fig. 16. Note particularly the method by

which the height of the roof is carried from the vertical measuring line to the center of the vertical plane of the house, and then carried forward to the center of the roof line projected from the plan. This principle of projecting each measurement to its proper plane, as demonstrated in Fig. 14, is applied in all perspective drawings of houses, in the projection of roofs, porches, wings of buildings, etc. When making the perspective drawing for Fig. 17 care should be taken that the lines of the roof, and other details in the elevation, are set back slightly from the vertical measuring line, which is in contact with the first step, and must be drawn accordingly.

18. Securing Proportions.—With the station point half way between V^L and V^R , the sides of the building to be drawn in perspective will be at an angle of 45° with the picture plane, and the drawing is said to be made in 45° perspective. This is shown in Fig. 11, where the sides of the house coincide with the sides of the triangle that makes a 45° angle with the picture plane LR .

If, as in Fig. 19, the station point is not equidistant from V^L and V^R , the center of vision, measuring points, and vanishing points are irregularly spaced, and much more work is required to attain the same results. In Fig. 19, the plan is laid out in perspective on a $30^\circ \times 60^\circ$ triangle, instead of on a 45° triangle as in Fig. 12. In Fig. 19, V is not midway between the principal vanishing points, and the center of vision C does not coincide with V , thus making one extra point to consider.

The distance from the vanishing point L to the measuring point l , however, must equal the distance from the vanishing point L to the station point; while the distance from the vanishing point R to the measuring point r must equal the distance from R to the station point. It is usually best to arrange the station point at 45° , and to set the object to the right or left of the center of vision in order to expose more of one side than of the other to view. The station point in a 45° perspective is located at its maximum distance from the picture plane, which is always a decided advantage, and the distance from the sta-

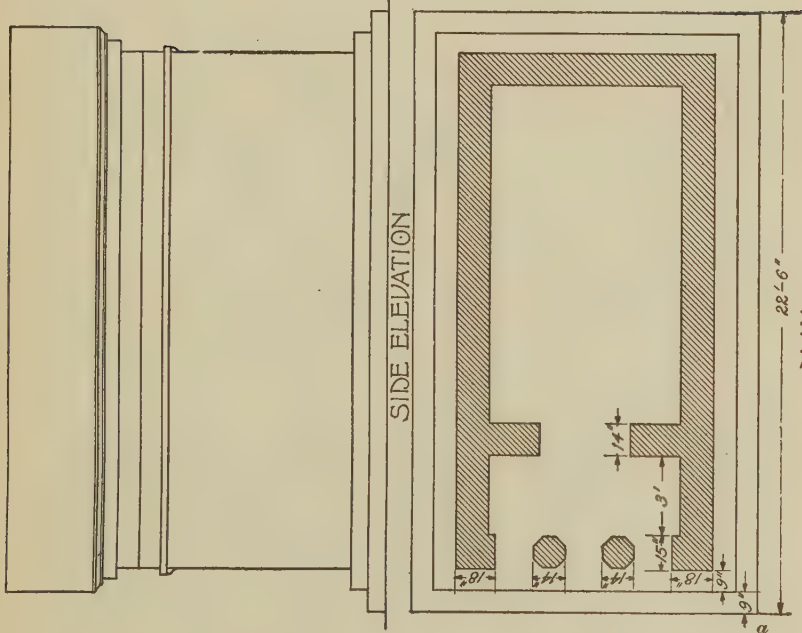
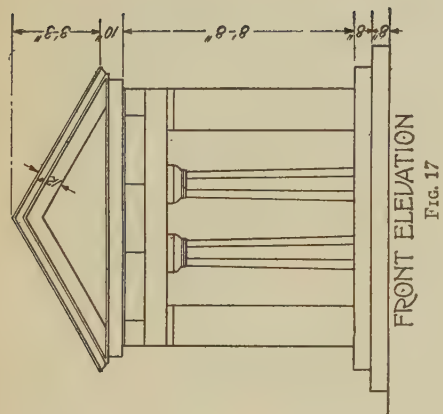




FIG 19

tion point to the picture plane is equal to one-half the distance between the principal vanishing points (see rule III, Art. 7). Therefore, as S is equidistant from V^L and V^R , it follows that M^L and M^R are equidistant each side of V^O .

It will be noticed that a point of simplicity in this arrangement is found in the ease with which the various measuring points and vanishing points may be located, it not being necessary to lay out these details on a large sheet, as will be seen by referring to Fig. 20, which is simply a diagram of one of the methods of laying out an octagon geometrically. From the

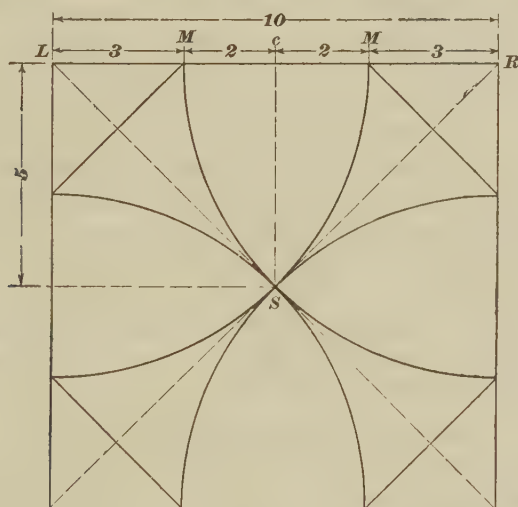


FIG. 20

four corners of a square, a distance is laid off on each side equal to one-half the diagonal, thus locating points from which lines may be drawn to cut off the corners of the square to reduce it to an octagon. The section of the square LSR will be found to correspond exactly with the horizon line and station point (Fig. 11), and the distances laid off on the side LR will be found to correspond exactly with the distances laid off for the measuring points on the horizon.

19. From the above it will be seen how it may be assumed that, for all practical purposes, in laying out a per-

spective at 45° , the distance from the horizon to the station point is equal to one-half the length of the horizon; the distance from the center of vision to the measuring points is one-fifth the horizon; and the distance from the measuring points to the nearest vanishing point is three-tenths the horizon. In other words, if the distance from V^L to V^R is divided into ten equal parts, then from S to V^O will be five parts, from V^O to M^R will be two parts, and from M^R or M^L to V^L or V^R will be three parts.

SUBDIVISION OF HORIZONTAL LINES

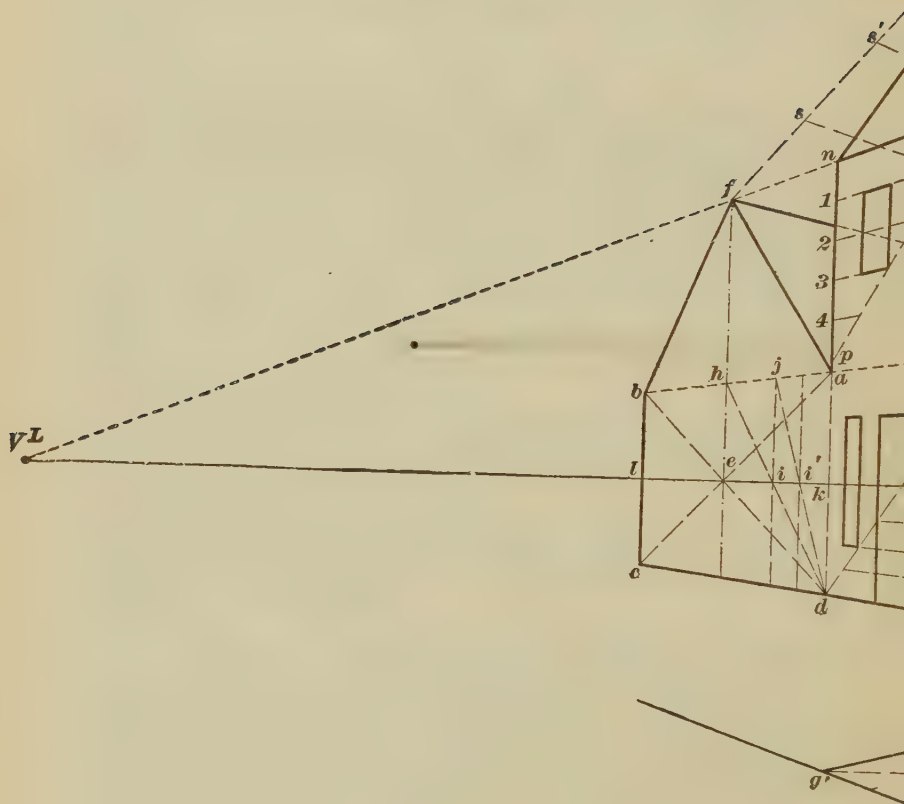
20. The division of vertical lines in perspective presents no difficulty, because the line is parallel with the picture plane and may be divided into two, three, or four equal parts, or into other relatively proportional parts, by direct measurements; but the division of horizontal lines that recede from the eye, except by projection from the perspective plan, is more difficult, as the subdivision most distant is shorter than the portion nearer the eye, and it is not always clear how much difference there should be.

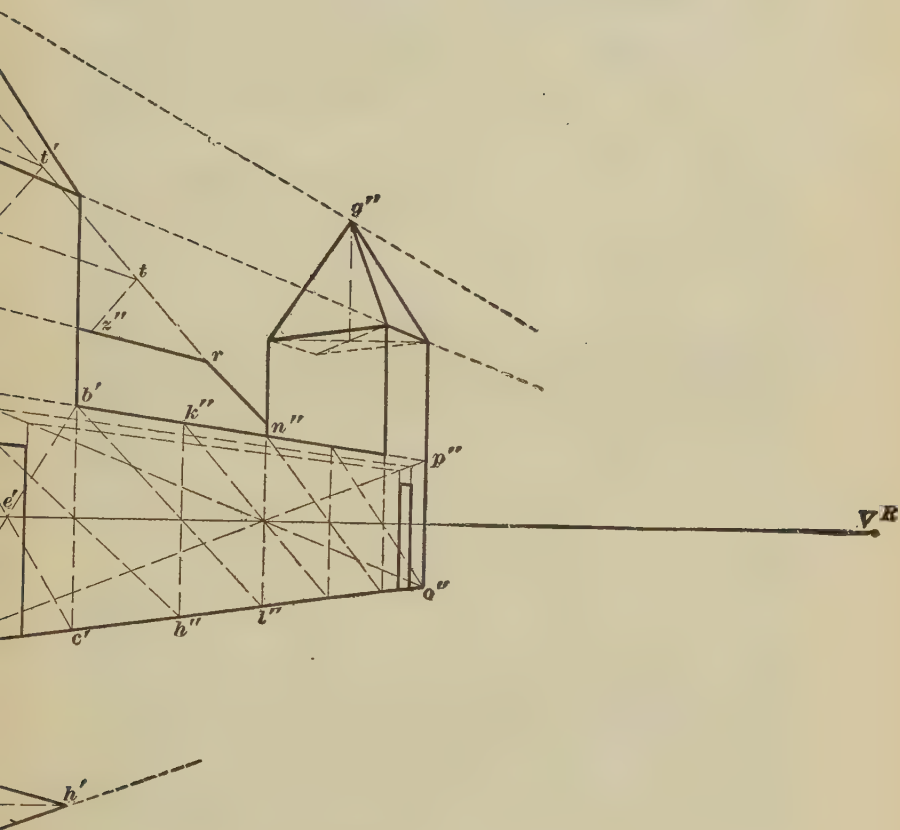
Two methods to determine these relative proportions have been adopted—one known as the *method of diagonals*, and the other as the *method of triangles*.

21. The **method of diagonals** is based on certain geometrical properties of the parallelogram, and can be considered in five cases.

22. Case I.—The diagonals of a parallelogram intersect at the center of the parallelogram, and a line drawn through their point of intersection, parallel with two of its sides, will bisect the other two sides of the parallelogram and also the parallelogram itself. The diagonals ab and cd of the parallelogram in Fig. 21 intersect at e , and the line fg drawn through their point of intersection e , parallel with the sides bc and ad , bisects the sides ac and bd and also the parallelogram itself, as shown.

In the parallelograms formed by means of the line fg , the diagonals ag and df intersect at h , and the line kl drawn





through the point of intersection h , parallel with the sides fg and ad , bisects the sides af and dg and also the parallelogram $adgf$.

By this method of diagonals it is seen that the line ac is divided into two equal parts by the line fg , whereas the distances ak and kf are each equal to one-quarter the line ac . The subdivision of this line into eighths, sixteenths, etc. can be readily carried out by subdividing the parallelograms formed by the diagonals, as shown.

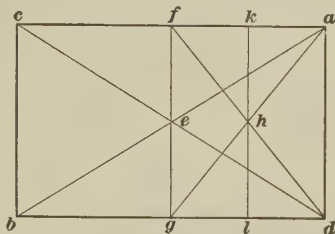


FIG. 21

23. The application of this case to a perspective drawing is shown in Fig. 22, where the side $abcd$ of a building is in the form of a parallelogram.

The diagonals ac and bd intersect at e , thus marking the center of this parallelogram, and the line ef drawn parallel with the vertical sides must pass through the center of the gable—the height of which is laid off on the corner of the building at f' —and by means of a vanishing line drawn from f' to the vanishing point V^L it must locate the point of the gable at f without further consideration of the plan.

In the same manner, the position of the point of the tower g can be located by means of the diagonals $g'h'$ and $k'l'$ in the plan. These diagonals intersect at o , showing directly the position of the apex at the point of the tower roof. The location of the apex of the more distant tower, shown at g'' , is found in the same way, the diagonals not being drawn in the ground plan, as the perspective ground plan does not extend to that part of the building; but a plan is drawn at the top of the tower itself, as shown, and a vertical line erected at the intersection of the diagonals.

24. Case II.—If through the intersection of the diagonals of a parallelogram a line is drawn parallel with two of the sides, a single line will thereafter be sufficient to establish any equal subdivisions of the other two sides, as shown in

Fig. 23, where the line ab is drawn through the intersection of the diagonals of the parallelogram at c , and the diagonal de , intersecting the line bc at f , bisects the line bc and also the smaller parallelogram $egdh$. A line drawn through f

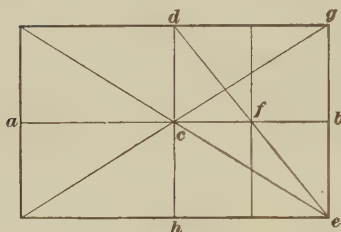


FIG. 23

parallel with eg will give precisely the same subdivisions in the parallelogram, Fig. 23, that were obtained in Fig. 21, but with fewer construction lines.

25. The application of this case in Fig. 22 is shown in the subdivision of the rect-

angular side $abcd$, where the line kl is drawn through the point of intersection of the diagonals at e toward the vanishing point at V^L . A diagonal drawn from d to h will then bisect the line ek at i , and a diagonal drawn from d to j will bisect the line ki at i' , thus subdividing the rectangle $abcd$ into two equal parts by the vertical line through e , into four equal parts, if desired, by vertical lines through i , and into eight equal parts by vertical lines through i' .

26. Case III.—If a line is drawn from a corner of a parallelogram through the center of one of the opposite sides of the parallelogram, and continued until it intersects with the other opposite side prolonged, the length of that side may thereby be doubled and likewise the parallelogram itself.

In Fig. 24 is shown a parallelogram $abcd$, from the corner a of which is drawn a line af passing through the

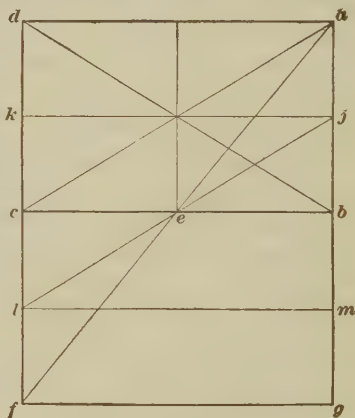


FIG. 24

center e of the opposite side cb and intersecting the opposite side dc prolonged at f . The distance cf is therefore equal to cd , and the parallelogram constructed at $cfgb$ is equal to the parallelogram $abcd$. If, now, the line jk is drawn through the intersection of the diagonals of the parallelogram $abcd$, and from j a line is drawn through e , the center of bc , thereby locating the point l on the line dc prolonged, the distance cl is equal to the distance ck , and the parallelogram $clmb$ is equal to the parallelogram $kcbj$, which is one-half the parallelogram $abcd$. In this manner the original parallelogram has been increased one-half in the latter case, and doubled in the first case.

27. The application of Case III in Fig. 22 is shown on the right side of the building where, at $a'b'c'd'$, is given a parallelogram forming the side of the tower; the diagonals $d'b'$ and $a'c'$ intersect at e' and mark the center of the parallelogram, through which a line is drawn to the vanishing point V^R .

If a line is drawn from a' through the center of the side $b'c'$ and continued until it intersects with $d'c'$ prolonged at h'' , another rectangle $b'c'h''k''$ equal in every respect to the parallelogram $a'b'c'd'$ can be constructed. And, again, drawing a line from b' through the center of the side $k''h''$ until it intersects with the line $c'h''$ prolonged to l'' , another parallelogram $k''h''l''n''$ can be constructed; and so on to the completion of that side of the building, the entire side consisting of six parallelograms, each equal to $a'b'c'd'$.

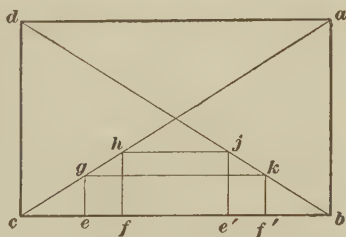


FIG. 25

28. Case IV.—If the side of a parallelogram is divided, in any manner, near one end, equal subdivisions may be laid off near the other end by means of the diagonals.

In the parallelogram $abcd$, Fig. 25, the diagonals ac and db are given, while at e and f are two points on the side cb

near the end c . If the lines eg and fh are drawn parallel with the side cd until they intersect with the diagonal ac , and from these points of intersection the lines hj and gk are drawn until they intersect with the diagonal db , lines drawn from the points j and k parallel with the side ab will intersect the line bc at e' and f' , so that the distances bf' and $e'f'$ will be equal to the distances ce and ef .

29. The application of Case IV in Fig. 22 is shown in the location of the door openings in the two towers, where the side lines of the door of the nearest tower are continued upwards until they intersect with the diagonal $a'o''$ of the parallelogram $a'p'o''d'$, and from these points of intersection, vanishing lines are drawn toward V^R until they intersect with the diagonal $p''d'$, and vertical lines drawn from these latter points of intersection will mark the width of the door in the more distant tower, as shown.

30. Case V.—If one side of a parallelogram is subdivided into parts of any relative proportion, either of the adjacent sides may be divided in the same proportion by means of one of the diagonals, and the relative positions of these proportional parts may be in the same or the reversed order, according to which of the diagonals is used.

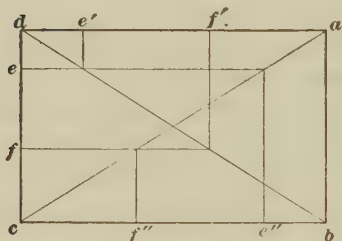


FIG. 26

In Fig. 26 is given a parallelogram $abcd$, the end of which is divided at e and f . If lines are drawn from e and f parallel with the side ad until they intersect with the diagonal bd , and from these points of intersection lines are drawn parallel with the side dc , these lines will subdivide the side ad at e' and f' so that the proportions of de' , $e'f'$, and $f'a$ will be the same as the proportions of de , ef , and fc . Or, if from e and f lines are drawn parallel with ad until they intersect with the diagonal ac , and from these points of intersection lines are drawn parallel with the side dc and

intersecting the side bc at e'' and f'' , the subdivisions of the line bc will be proportional to the subdivisions of the line cd , but in the reversed order from the subdivisions, as laid out on the other diagonal for the line ad .

31. The application of this case to Fig. 22 is shown in the location of the windows on each side of the door opening in the nearer tower. The distance md' on the corner of the tower is laid off equal to the scale width of the tower in elevation, and at $m-1$, $m-2$, $m-3$, etc. are laid off the scale measurements of the windows and doors, $m-1$ being the scale distance from the corner of the tower to the edge of the window, $1-2$ the width of the window, $2-3$ the space between the window and the door, $3-4$ the width of the door, etc. Lines drawn from 1 , 2 , 3 , 4 , etc. toward the vanishing point V^L intersect the diagonal md at points through which vertical lines may be drawn to establish the width of the windows and door.

32. It is evident from this that a definite length of a given parallelogram in the perspective drawing is unnecessary, as the line $a'd'$ can be laid off in any place and at any convenient length, so long as its subdivisions may be carried toward a vanishing point and be intersected by a diagonal.

For instance, on the farther corner of the left-hand side of the tower there are laid off, from n to p , certain subdivisions corresponding with the width of the windows and the spaces between them in the upper part of the tower. A diagonal then drawn from p to f' furnishes a line on which the subdivisions between n and p may be laid off for the windows, by means of vanishing lines drawn from V^L through the subdivisions between n and p to intersect on pf' . The distance np may be laid off arbitrarily, longer or shorter, as here shown, and the subdivisions $n-1$, $n-2$, $n-3$, etc. may be at any convenient scale, so long as the total distance np equals the scale width of the tower in elevation. The line nf' is fixed, however, as it represents the width of the tower in perspective, and lines drawn from the vanishing point V^L through the subdivisions of the scale width of the

tower np will intersect on the diagonal pf' , so as to locate the subdivisions across the apparent width of the tower in perspective.

33. In the application of each of these five cases, all lines running to the same vanishing point have been considered as being parallel, whereas all vertical lines actually are parallel, and if this is well borne in mind, difficulty in transferring measurements from scale elevations to perspective surfaces will never be encountered.

34. The Method of Triangles.—In the application of the last case, it will be observed that only one-half of the parallelogram has been used, and though the principle involved is that of the diagonal of a parallelogram the problem resolves itself into the use of a triangle.

Therefore, Case V might be stated definitely as follows: If one side of a triangle, as dc , Fig. 26, is divided into any relative proportions, the adjacent side da may be divided into similar proportions by lines drawn parallel with the two sides and meeting on the third side ac .

35. The last application of this case also gives rise to a proposition, that if from one end of any given line in a perspective drawing another line is set up parallel with the picture plane, any subdivisions laid off on the lines so set up may be transferred, proportionately, to the given line on which it is set up by means of a third line connecting the last point taken on the set-up line and the other end of the line.

The application of this principle in Fig. 22 is shown in the location of the lightning rods along the roof of the building at fr , where from f , a line fx is erected arbitrarily and divided into three equal parts at s and s' , and from x a line is drawn to r , completing the triangle fxr . This triangle may be of any size or proportion, but the side fr must always be the same. Lines then drawn from s and s' to the vanishing point V^R (V^R being the vanishing point of the given line fr) will intersect the line xr at points t' and t , from

which points of intersection lines drawn parallel with fx will intersect the given line fr at points z' and z'' , which mark the location of the lightning rods along the ridge.

This same principle may be used at any time to locate any number of equal or proportional subdivisions in any perspective line whatever, thus eliminating from the perspective plan much detail that would otherwise be required.

INCLINED PLANES

36. Besides the vertical and horizontal planes that are parallel with the ground and with the picture plane, it is sometimes necessary to find the vanishing points of lines that form the boundaries of inclined planes, such as the slopes of roofs, etc.

In Fig. 27 is shown a bird's-eye view of a simple four-gabled building. The lines parallel with the sides of the building vanish at V^R and V^L , as these lines are at 45° with the picture plane and parallel with the ground, but lines parallel with the roof slopes are inclined at an angle of 45° , and the vanishing points of these lines will be somewhere above or below the regular vanishing points V^R and V^L . If diagonals are drawn in the end rectangle $abcd$, the center point o can be found, and a perpendicular can be erected that will mark the center line oe of the gable aeb . The height of e can be laid off at any point on the scale line, projected around and located on the line oe . The same can be done with the points of each of the other four gables, but when lines ae and mn are drawn, it will be found that they intersect at V^M , while gl and rp prolonged intersect at V^N . In the same manner, it will be found that eb and lh intersect with the vertical lines through V^L and V^R at points $V^{M'}$ and $V^{N'}$. Therefore, the points V^M and $V^{M'}$ and V^N and $V^{N'}$ are the vanishing points of lines inclined to the right and left at an angle of 45° and upwards, parallel with the roof slopes, and all lines in the roof slopes inclined at the same angle over a plan placed at 45° with the horizon will intersect at these points. It will be observed, however, that the vanishing

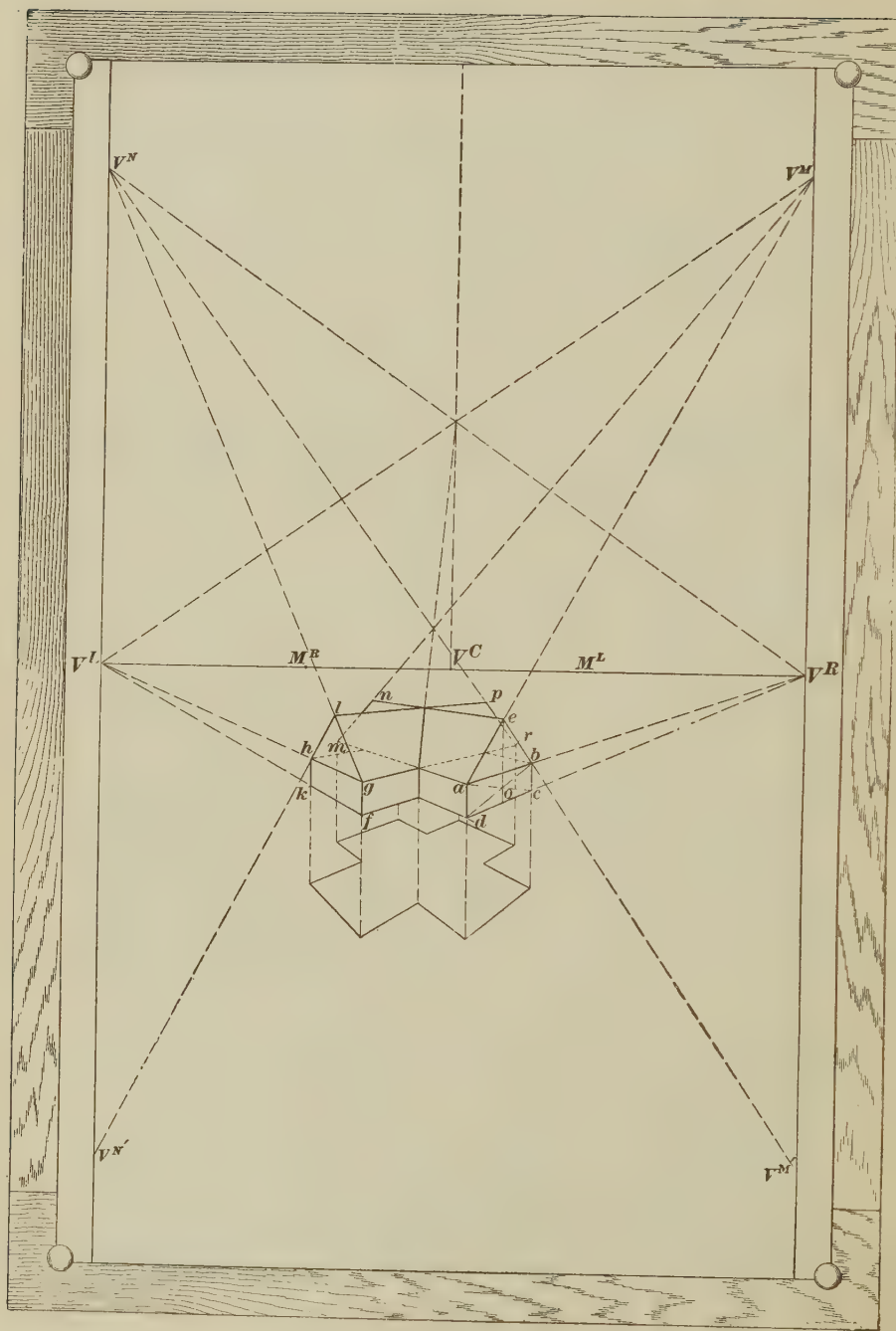


FIG. 27

points of these 45° lines are in line with the points V^L and V^R ; therefore, if, in laying out a perspective, vertical lines are drawn through V^L and V^R , on these lines prolonged will be found the intersection of all the vanishing lines inclined upwards or downwards to the right and left and at an angle of 45° with the picture plane. Therefore, instead of laying out the center line of the gable oe , it will simply be necessary to project the lines directly from the corners of the front of the building, as from a toward V^M and from $V^{M'}$ through b to e .

37. In Fig. 28 is shown a method of getting these vanishing points quite as simply as the other vanishing points are obtained, so that the points may all be determined before the perspective drawing is commenced. After drawing the horizontal line V^L-V^R , and locating V^C , M^R , and M^L , draw through V^R-V^L vertical lines indefinitely, as shown. From M^R and M^L , draw diagonals with the triangles set at an angle of 30° or 45° , as shown, when the lines of the roof slopes or other lines are inclined at an angle of 30° or 45° . The points V^M , V^N , $V^{M'}$, and $V^{N'}$ on the vertical lines through V^L and V^R are then established as the vanishing points of lines at an angle of 45° , while V^{M^2} , V^{N^2} , V^{M^3} , and V^{N^3} , in a like manner, show the vanishing points of lines inclined at an angle of 30° .

It should be noted that the angle at which these vanishing points are laid off is made at the measuring point, thus showing another useful application of this system. Where the lines from V^L to V^M and V^R to V^N intersect will be found the vanishing point of the line of intersection between the inclined planes, or, in other words, the valley of the roof slope, V^P and $V^{P'}$ being the vanishing points of the intersections of roof slopes at an angle of 45° , while V^Q and $V^{Q'}$ show the vanishing points of lines of intersection of the roof slopes at 30° . These facts should be carefully studied and various sketches made of these and the previous problems, in order that the fundamental principles of perspective drawing may be clearly understood.

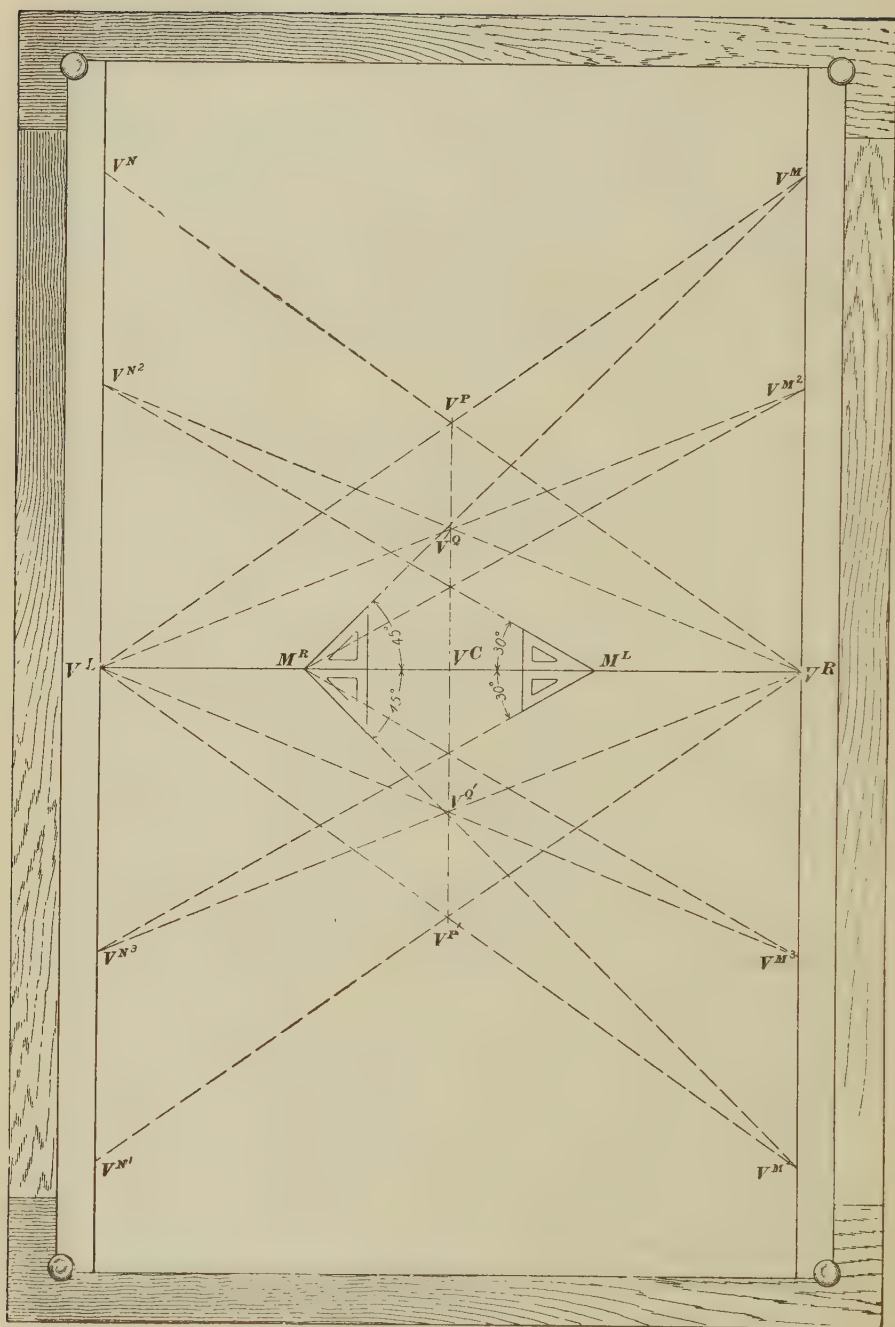


FIG. 28

38. Any part of an object in contact with the picture plane may be laid off to a proportional scale direct (rule I, Art. 7), and if the perspective is to be drawn full size, the details of the object in contact with the picture plane may be laid off to a full-size scale. On the other hand, if it is assumed that the object itself is replaced by a small model on a scale of one-half size or a smaller scale of $\frac{1}{8}$ or $\frac{1}{16}$ inch to the foot (as is usually the case with a house), and that this model is in contact with the picture plane, then the perspective may be considered a full-size drawing of the *model*, and a $\frac{1}{8}$ - or $\frac{1}{16}$ -inch scale, as the case may demand, may be used for the measurements.

39. In Fig. 29, the horizontal line has been drawn about 5 inches in length, and the principal points have been located thereon, according to the proportions given in Fig. 20. At abc , Fig. 29, a line is drawn at any convenient distance below the horizon, and from b toward a the length of the side of the house is laid off, while from b toward c the details of the front of the house are laid off. Lines are first drawn from b to V^L and V^R . Lines drawn from the divisions on bc toward M^R subdivide the perspective view of the end of the house, and a line drawn from a toward M^L limits the perspective length of the side of the house. Thus, the two sides of the house and the details they contain may be located and proportioned.

40. By drawing diagonals through the parallelogram in the elevation forming the end of the house, the vertical center line can be located and thereby the position of the point of the gable can be established. On the line formed by the corner of the house in contact with the line of measures, abc can be measured, at h , d , and e , 21' 0'', 12' 0'', and 7' 6'', the heights of the two slopes of the gable, as shown on the front elevation, and where a line from the highest point e toward V^R intersects this vertical center line is located the peak of the gable. V^M and $V^{M'}$ are readily located from M^R by means of a 30° triangle, and the slopes from the peak of the roof toward V^M and $V^{M'}$ can be laid out, and at the same time establish by their intersection with the line

line from which will intersect with the ridge and mark a point f where the 30° slope can be laid off on that end, and the intersection of this, at g , with the line drawn toward V^L will locate the points required for the slope on this end.

PARALLEL PERSPECTIVE

42. Difference Between Parallel Perspective and 45° Perspective.—Now will be considered the perspective rendering of objects whose sides, instead of inclining at an angle of 45° with the picture plane are perpendicular to the picture plane; in other words, rectangular objects that are so placed that one side is parallel with the picture plane, and the other side at right angles to it. In 45° perspective, V^L and V^R are equidistant from V^C , and the measuring points

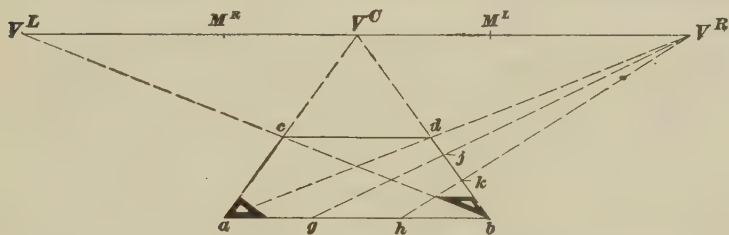


FIG. 30

M^L and M^R are also symmetrically disposed on each side of the center. In parallel perspective, the same layout of the various points can be assumed, but the main vanishing point will be V^C in the center of the picture, and V^L and V^R will then become the vanishing points of 45° .

43. In Fig. 30 is shown a horizontal line V^L-V^R with the several points located as explained in Fig. 20. At $abcd$ is shown the perspective plan of a square. The sides ab and cd are parallel with the picture plane, and ac and bd are perpendicular to the picture plane; therefore, the latter vanish at V^C . Thus, the diagonals of the square ad and bc are at an angle of 45° with ab and cd , and consequently at the same angle with the picture plane. These diagonals must then vanish toward V^L and V^R . Then, ab is equal to bd , and

any distance laid down on ab can be transferred to bd or ac by lines drawn toward V^R or V^L . Thus, jk on bd is the perspective representation of the distance gh on ab .

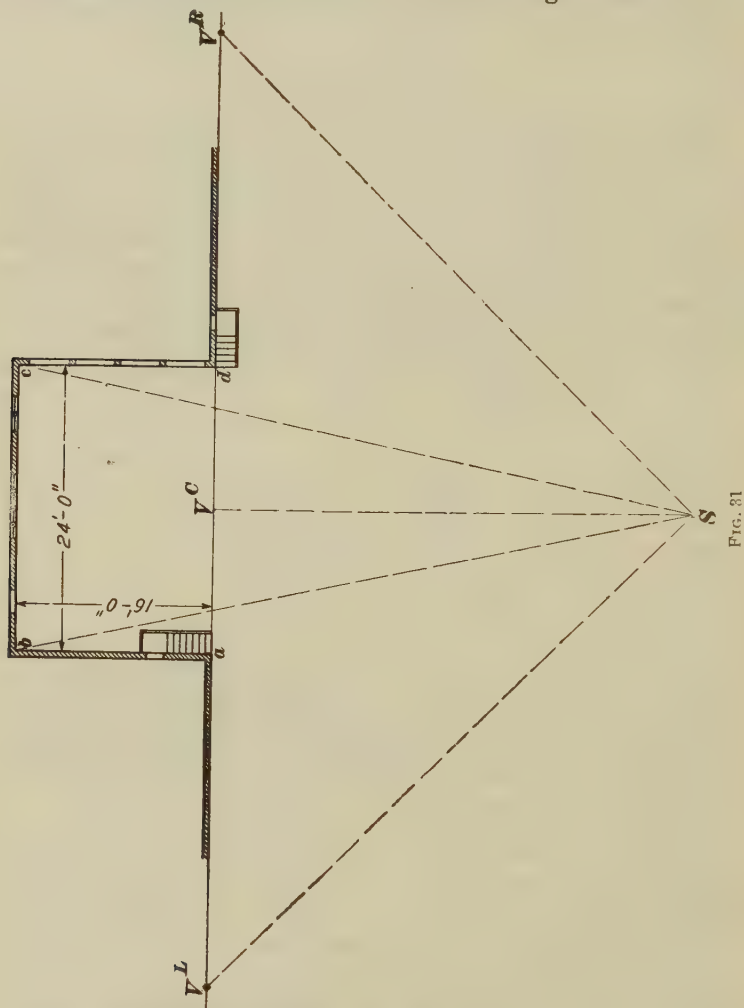


FIG. 31

44. In Fig. 31 is shown the plan of a court surrounded by buildings; the sides ab and dc of the buildings are perpendicular to the picture plane, while the side bc is parallel with

the picture plane. It has already been explained (rule I, Art. 7) that all lines in a plane parallel with the picture plane can be drawn to the same scale, and when in contact with the picture plane may be drawn full size.

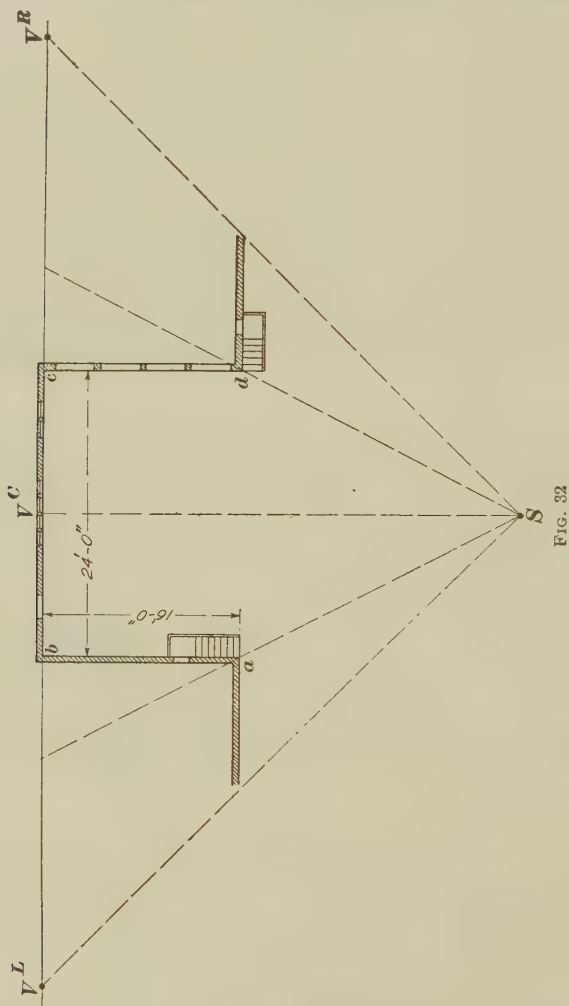
Therefore, the portions of the building in contact with the picture plane at a and d may be laid out regularly to the full scale of the plan, and the steps going up to the right from d may have their ends next to the picture plane laid out in their actual scale and proportionate size. The proportions of all parts of the building in contact with the picture plane may be laid out as a simple elevation and the relative lines projected therefrom toward the vanishing point V^c , so as to intersect with vertical lines from the perspective plan drawn to limit the width of the buildings in the back of the court, which are then, in themselves, drawn in elevation.

45. Change of Position of Picture Plane.—It is not at all unusual, in making drawings in parallel perspective, to reverse the order of things somewhat and to place the picture plane behind the object to be drawn, projecting the lines of sight from S back toward the picture plane. This is shown in Fig. 32, where the plan of the court $abcd$ is entirely in front of the picture plane. The station point is at S , and projection lines are drawn from the station point back through the principal points of the building until they intersect with the picture plane. The advantage in this method consists in the fact that the entire façade of the building bc is in the picture plane and can be drawn to scale as an elevation.

46. The effect of these arrangements, when working with a perspective plan, is shown in Fig. 33. At any convenient distance below the horizon (though in many cases the farther below the better), the perspective plan of our court is drawn as follows:

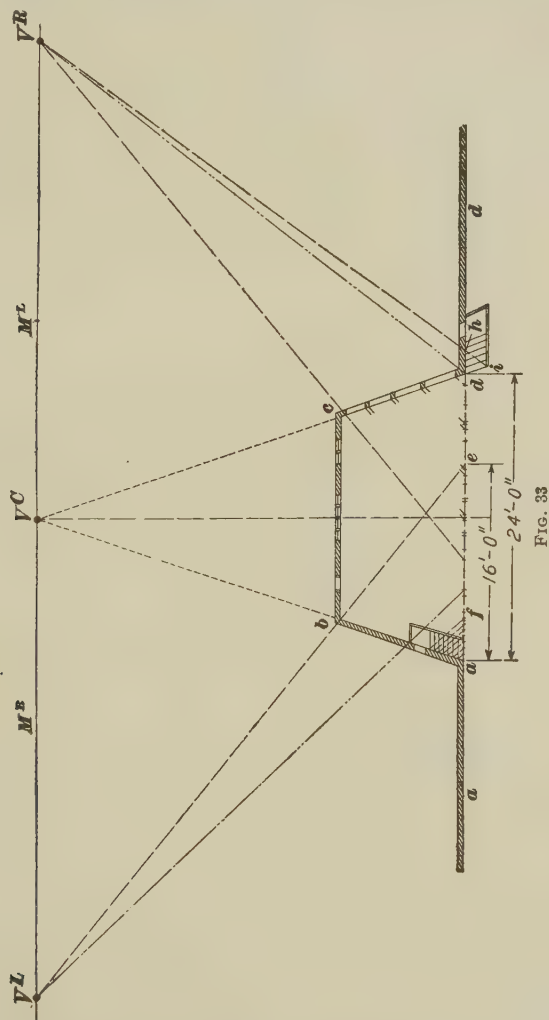
The fronts of the buildings nearest, as shown at aa and dd in the plan, are drawn to their full scale of $\frac{1}{16}$ or $\frac{1}{8}$ inch to the foot, according to the scale of the perspective required, the distance ad being the same as the distance ad in the

scale plan shown in Figs. 31 and 32. The lines ab and dc converge toward V^c , and the perspective depth of the court is ascertained by laying off from a toward d a distance ae



of $16' 0''$, which is equal to the scale depth in the plan, Fig. 31, and drawing a line to the 45° vanishing point V^L . This makes the triangle acb the perspective view of a right

triangle, with the right angle at a and the angles at b and e equal to 45° , the same as abd , in Fig. 30. Therefore, the side ab must equal the side ae .



47. Laying Out Plan of the Steps.—The plan of the steps is laid out in the same manner, on the left side the width of each successive tread of the steps being laid off

from a toward f and lines drawn toward V^L to mark these widths on the side of the house ab . The width of the treads of the steps on the right side can be laid out to actual scale along the side of the house dd , and lines drawn from V^C through them will mark them in plan, whereas their length beyond the line dd is determined, as before, by measuring off a distance from d to h equal to the width of the steps and drawing a line toward V^R , thus making di equal to dh and the triangle dih , a right triangle in perspective, with its right angle at d . In this case, the steps are *between* the eye and the picture plane, and are therefore drawn to a larger scale than that used to draw the details actually in contact with the picture plane itself.

48. In Fig. 34, a perspective plan is laid out in precisely the same manner, except that bc is assumed to be in the picture plane, and this end of the court is laid out to full scale, drawing lines from V^C through b and c toward a and d and determining the length of the side ab , as before, by measuring from b toward c a distance be of $16' 0''$, equal to the scale length of the side ab , also, drawing through the point e , so located, a line from V^R ; constructing, thereby, in perspective, a right triangle abe , with a right angle at b and 45° angles at e and a , making the side ba equal to the side be .

49. As all lines drawn toward V^R or V^L are at 45° with the picture plane, and as all lines drawn toward V^C are perpendicular to the picture plane, it stands to reason that a line from d to V^R will be at 45° with cd and that the angles $c-d-V^R$ and $d-d-V^R$ are both 45° . If, then, from h , the point where the line from d to V^R intersects the picture plane PP the distance hk equal to the width of the steps in front of dd is laid off, and from V^R through k the line ki is drawn, there will be found, where this line intersects cd prolonged, the width of the steps, in perspective, at di . The other steps at the corner a are laid out by measuring their scale width at bf and projecting it by means of a line from V^C through f to g .

50. Method Used in Practice.—In practice, where the plan is constructed in front of the plane of measures, as in this case, and there is much detail to be drawn on the

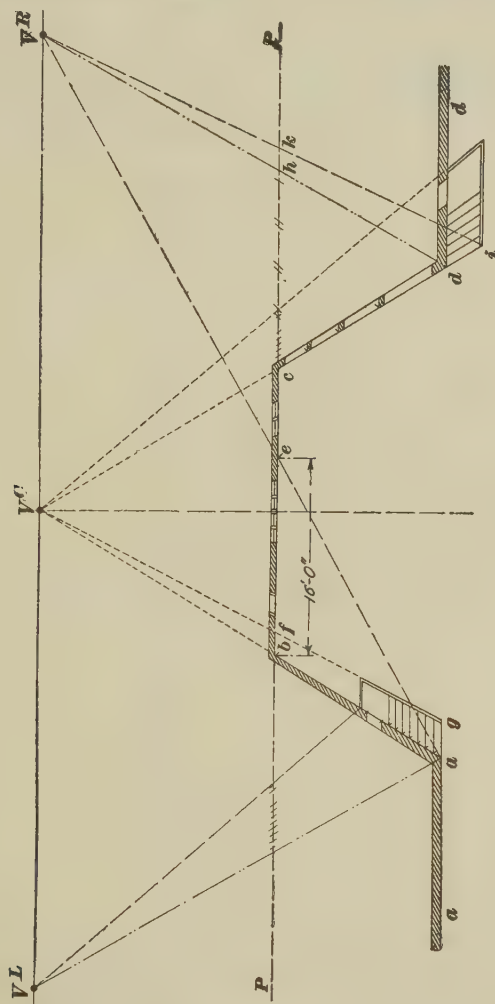


FIG. 34

sides aa and dd , it is wise to construct a *new scale* for use on the sides aa and dd . This can be done by simply laying off, to scale, a few equal divisions of 1 foot each on the

picture plane and drawing lines from V^c through them until these lines intersect with a new plane coincident with aa and dd . This will give a new scale of feet by which all the details of aa and dd may be laid out.

51. Changing the Scale.—There is another condition in which a change of scale is very convenient and often imperative, which it will be well to explain here. At $abcd$,

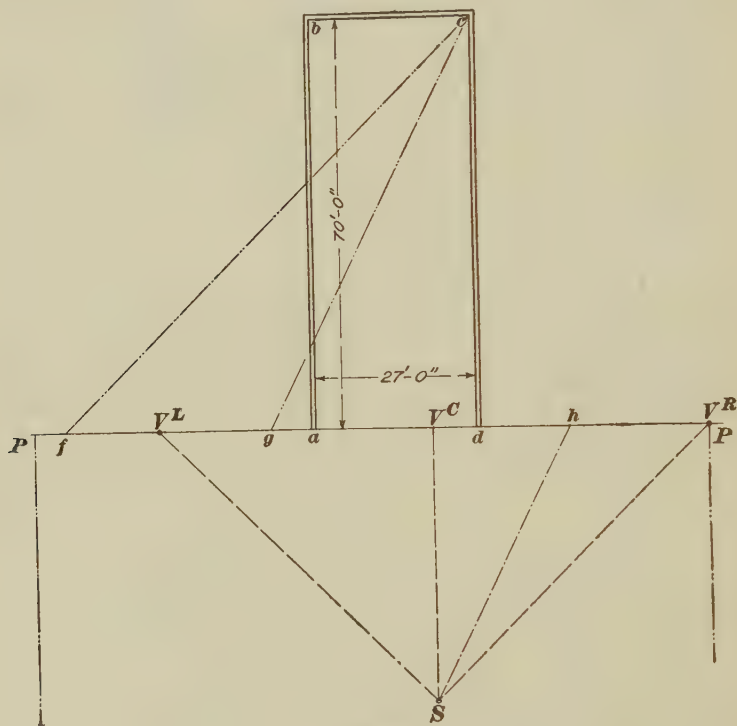


FIG. 35

Fig. 35, is shown a room or hall. The station point is at S , and the picture plane at PP . In order to locate in a perspective plan certain points that will give the depth of this room, it will be necessary to lay out, toward the left from d , Fig. 36, a distance df of $70' 0''$, equal to dc , Fig. 35, and

draw a line from f toward the vanishing point V^R . But circumstances might be such that there will not be space to lay out so great a distance to the left of d —only space enough for one-half or one-quarter of this distance, according to the depth of the hall. Inasmuch as a line drawn from f to c , Fig. 35, is parallel with the line from S to V^R , it stands to reason that a line drawn from a point g half way between d

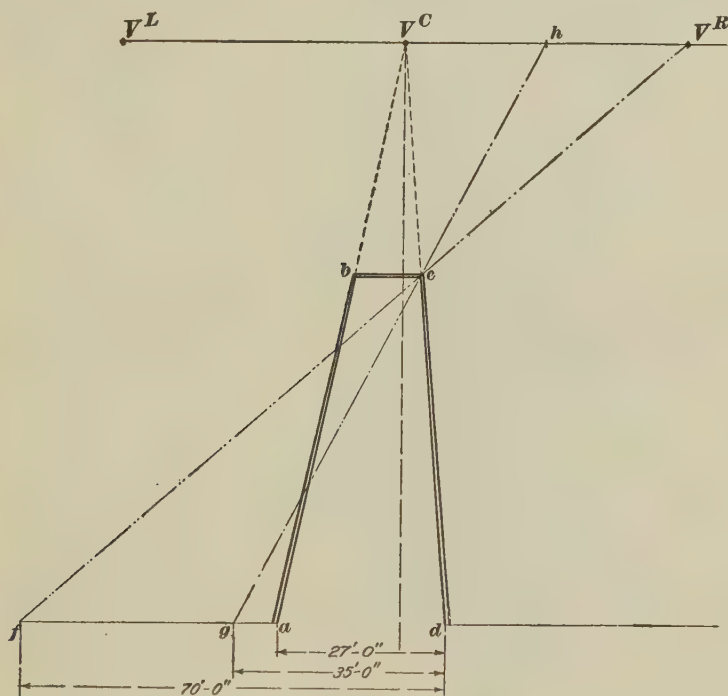


FIG. 36

and f toward c will be parallel with a line drawn from S to a point h , half way between V^C and V^R .

Therefore, in order to locate the depth of dc in perspective, Fig. 36, lay off, to the left of d , a distance dg equal to one-half the distance dc , Fig. 35, and draw from g a line to a point h half way between V^C and V^R . This line will locate on the line from d to V^C the corner c , as shown in Fig. 36.

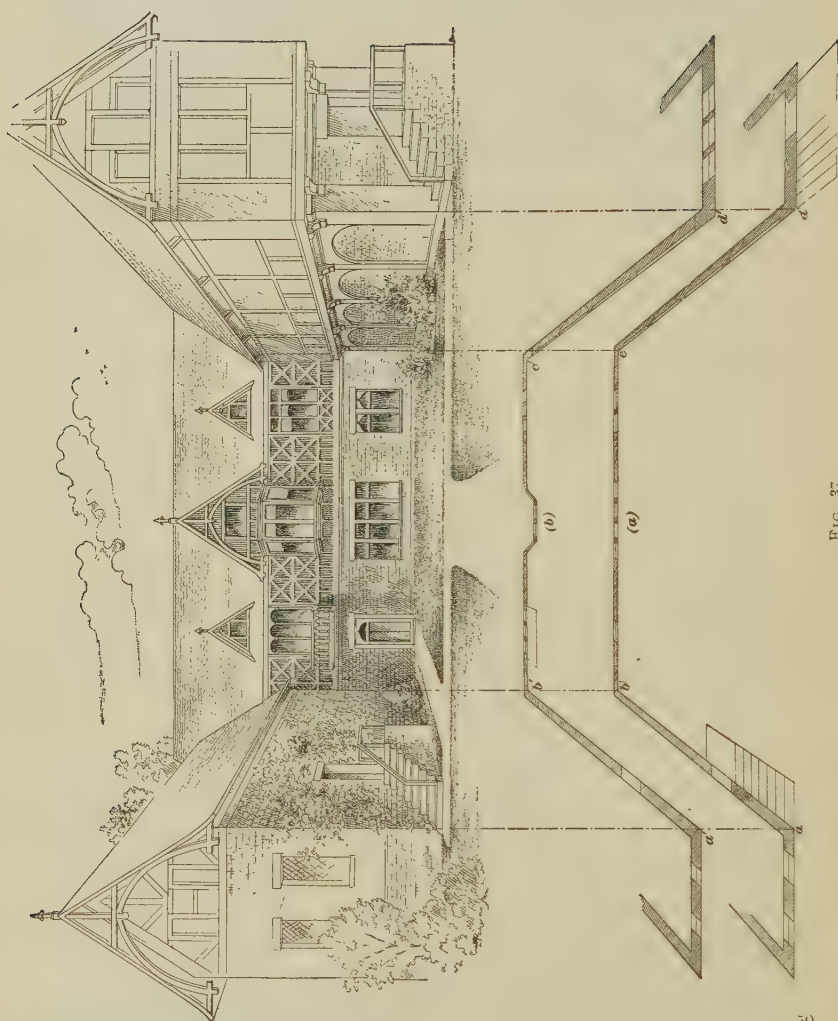


FIG. 27

52. In Fig. 37 (*a*) is shown the perspective plan of the first story of the court, and at (*b*) the perspective plan of the second story of the court, referred to in Figs. 31 and 32, and above them, drawn in simple elevation, is that portion of the façade of the building which lies in the picture plane coincident with bc of the plan. The steps at each side of the court are determined in the same manner as explained in Figs. 33 and 34, but it will be noticed that the façade of the second story $b'c'$ is narrower than that below, thereby showing that $c'd'$ projects slightly over and beyond cd . This illustrates very clearly the advantage of using a perspective plan, as all these details of projection can be shown in their relative positions without the slightest confusion, and the entire plan can be laid out with perfect convenience and all points located for proper projection into the picture.

53. Determining Proper Method of Procedure.

In determining which procedure is necessary in parallel perspective—that of assuming the picture plane entirely in front of the object, as in Fig. 33, or that of having it entirely behind, as in Fig. 34—consideration must be given to the amount of distance effect that it is desired to produce. In general practice, it is convenient to determine the relative proportions of a street or interior at the very beginning. That is to say, having determined on a scale to which the nearest portions of the object are to be drawn, the most distant portions may then be drawn to any suitable size and set as far up or as far down, or to one side or the other, as will give them the best appearance. Vanishing lines then drawn through the corresponding angles of the two ends will determine V^c and the height of the horizon.

54. A clearer idea of this proceeding may be obtained from Fig. 38, wherein the elevation of the back of the court is shown drawn to scale and the fronts to the left and right of ax and dy are drawn to any desired scale—in this instance, so that the height of the eaves is xa and yd . Lines drawn from a and d through b and c meet at V^c , and thus locate the vanishing point V^c and the height of the horizon.

Other lines drawn from V^c to x and V^c to y give, in outline, a perspective plan $xuwy$ from which V^L and V^R may be located. From x is laid off to the right a distance xg equal to the actual scale depth of the court, and a line is drawn

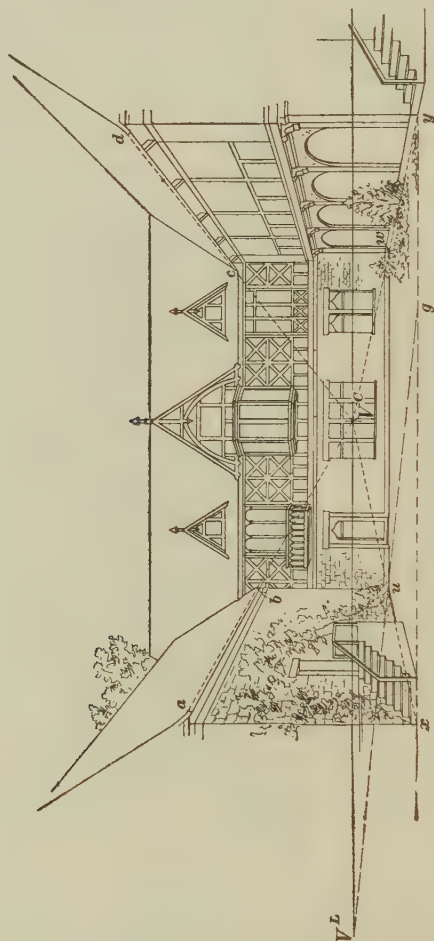


FIG. 38

from g through u until it intersects with the horizon line; the point of intersection will be V^L , and the distance V^L . V^c will be equal to the distance from V^c to S , which is the station point (see Fig. 20).

55. It may seem somewhat irregular to make a drawing by this inverse method, especially after having considered so carefully the importance of locating the station point and horizon line heretofore; but in parallel perspective, there being but one vanishing point, the effect is likely to be deceptive, as the location of the station point is not naturally taken into consideration by the spectator, and the size and proportions of objects are judged by the effect of distance instead of from the point from which they are viewed.

In Fig. 39 are shown two perspective sketches made by this method; in one of them (*a*) the station point is twice

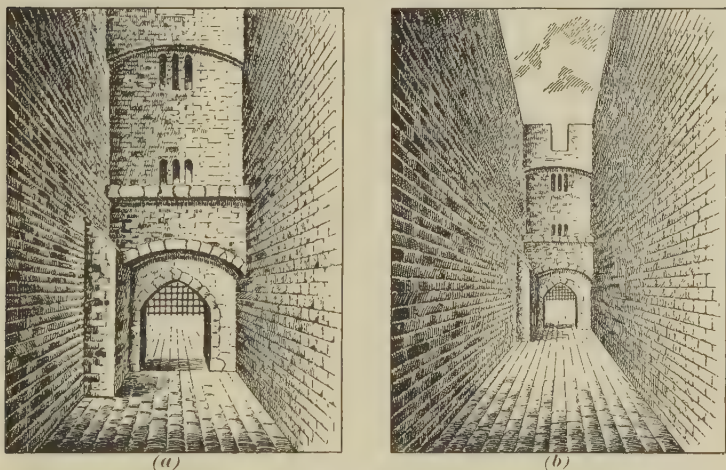


FIG. 39

as far away as in the other (*b*), and though they are both drawn to exactly the same scale the effect is materially different. So far as the lines of the drawing are concerned, the effect of distance is produced by placing the station point near to the nearest part of the object shown, thus producing considerable contrast between the relative sizes of the nearest object and those most distant. This, however, though desirable in the representation of streets and halls, is undesirable in the representation of rooms of medium size.

BIRD'S-EYE VIEWS

56. Perspective Applied to Bird's-Eye Views.

Occasions arise when the architectural draftsman is required to make a drawing for a bird's-eye view of the grounds of some manufacturing plant, or even as an illustration for some real-estate advertisement.

Bird's-eye views are simply perspective views with the horizon very high, as if viewed by the observer from the top of a high building or a balloon, or as viewed by the eye of a bird hundreds of feet above the ground; whence the name *bird's-eye view*. Sometimes the architectural draftsman is called upon to make a bird's-eye view of a group of factory buildings, or similar scene, for use in a catalog or prospectus, or on the bill heads, letter paper, and envelopes of the firm.

Generally no photograph or drawing can be made direct from the scene, because there is no elevated point from which such photograph or drawing can be made, and, besides, such a view is sometimes asked for before the buildings are constructed. The draftsman, therefore, has nothing to work from except a plan showing the location of buildings, trees, fields, fences, streams, etc., in the scene. This plan is absolutely necessary in order to get the correct relative positions of the various buildings, trees, fields, streams, etc., and can be obtained, usually drawn to a definite scale, from the people for whom the work is being done.

When such a plan is used, it is first lightly ruled with squares so as to chart it off into definite sections. When a bird's-eye view is then being made, it is a simple matter to establish the horizon well up in the picture and at a convenient distance below (say 100 feet, to scale) to place the ground line. The actual length of the nearest part (bottom) of the "map" is laid off on the ground line in the perspective, or bird's-eye, view, and then the network of squares or sections, as drawn on the map or plan, is laid out in perspective, thus determining the positions of the various buildings, etc. The actual heights of the buildings may be laid off on vertical measuring lines or

plotted in freehand. Any details of landscape accessories, such as streams, trees, fences, etc., may then be sketched in on the bird's-eye view in the same general relation to the individual squares of the network as they bear to the corresponding squares in the plan. In this way the bird's-eye view may be plotted pictorially in outline and then rendered as desired.

PERSPECTIVE OF CIRCLES

57. Difference in Perspective Drawing of Curved and Straight Lines.—There has been considered so far only the perspective drawing of straight lines, whose vanishing points could always be located by looking in the direction of the line and observing where it pierced the picture plane. With curved lines, however, an entirely different condition of

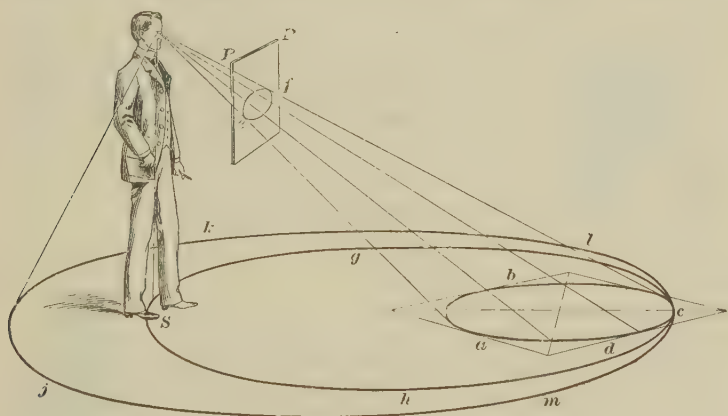


FIG. 40

affairs is met, because, on account of their changing direction, they may not come in contact with the picture plane at all, but may remain entirely beyond it.

Lines of sight, however, from the eye of the spectator to the contour of the curves will pierce the picture plane in such a manner as to locate a number of points that can be connected and represent the perspective of the arc. It will thus be understood that the spectator looking at the

circle will have his lines of sight represent, in space, an imaginary cone, the base of which will be the circle in question, and the apex, the meeting of the lines of sight at his eye.

This is shown somewhat more clearly in Fig. 40, where the spectator, standing at S and regarding the circle $abcd$, forms an imaginary cone of rays with his eye at the vertex and the circle at the base. If this cone of rays is cut through at any point by the picture plane, as shown at PP , its intersection will be an ellipse, as shown at ef , as it has been already learned that any section of a cone caused by a plane passing through two sides of the cone produces a circle or an ellipse.

In perspective drawing, all representations of the circle are either ellipses, parabolas, or hyperbolas, according to the position of the spectator with reference to the circle.

58. In Fig. 40, the spectator standing at S sees the circle $abcd$ as an ellipse. However, he is standing on the edge of the circle $Sgch$, and any portion of a curve of that circle that appears on the picture plane PP will be the arc of a parabola, and any portion of the arc of the circle $jklm$, entirely within which he

is standing, will appear as the arc of a hyperbola. The reason for this can be seen by a comparison with Fig. 41 (a), where abc is an oblique cone cut through by a perpendicular

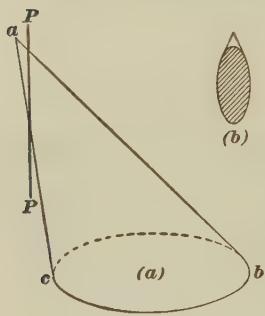


FIG. 41



FIG. 42

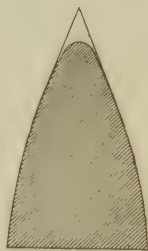


FIG. 43

plane PP that passes through both of its elements ab and ac . The conic section produced by this is shown in (b) as an ellipse, and corresponds to the conditions of the spectator in Fig. 40 viewing the circle $abcd$.

59. In Fig. 42, the cone is shown corresponding to that one formed by the spectator standing on the edge of the circle; it is still an oblique cone, and the plane of the picture passes through the base parallel to one of its sides, thereby making the section a parabola, Fig. 43. In Fig. 44, the spectator stands within the cone itself, and the plane of the picture passes through the base of the cone and forms a hyperbola by its section, Fig. 45. However, in the majority of cases, the circle appears as an ellipse in perspective.

60. Projection of Circular Forms.

In projecting circular forms to the picture plane, it is always simplest to determine their form by means of relative points on straight lines. As has

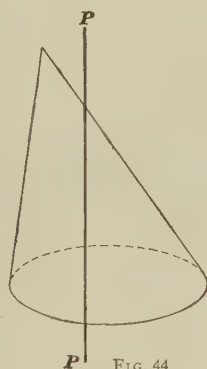


FIG. 44

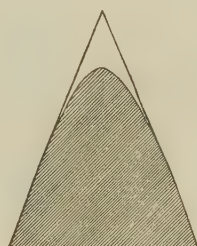


FIG. 45

been shown, it is a simple matter to project a perspective view of a rectangle. If now the circle is considered enclosed in a square, as shown circumscribed in Fig. 40, it will be easy to draw that square in perspective and to note where the circumference of the circle intersects the diagonals of the square. These points and the points of tangency on the four sides of the square will give eight points on the picture plane, through which can be drawn the ellipse representing the perspective of the circle.

61. In Fig. 46, at mm , is shown a measuring line on which a , e , d , and b are laid off in the proportion of the side of an enclosed octagon, as in Fig. 20. The octagon enclosed

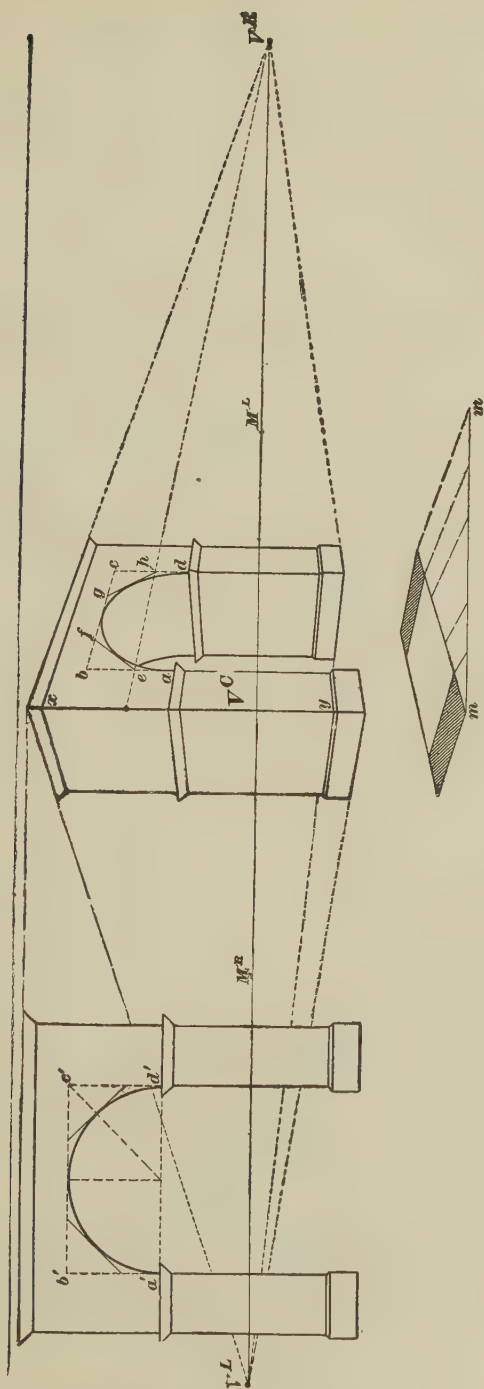


FIG. 47

true height on the corner of the arch xy , which is in the picture plane, and projecting it to its true place by a line toward V^R , as shown; or, after locating f , a line may be drawn through f toward $V^{M'45}$ —the vanishing point of lines inclined at an angle of 45° above the horizon. The side gh of the octagon can then be simply drawn toward $V^{M'45}$, or the points may be projected from the corner xy of the arch and drawn in as before suggested, the construction of the ellipse after the octagon is formed being simply a matter of freehand sketching.

63. In Fig. 48 is shown an ordinary cast-iron pulley wheel, the perspective rendering of which consists almost entirely of ellipses. In this case, as before, the circle representing the rim of the wheel is considered as being enclosed in a rectangle or octagon, as shown at $abcd$. The perspective of this rectangle appears in the form of a rectangular box, inasmuch as the wheel has considerable thickness, and two ellipses are drawn for the rim—one in the front of the box and the other in the bottom of it. The hub of the wheel in the middle is constructed in a smaller rectangle in the same manner. The lines at the top and bottom of the wheel that connect the ellipses and represent the thickness or breadth of the rim are drawn toward V^L as shown.

64. In Fig. 49 is shown another wheel, the rim of which is much narrower than the previous one, and for all practical purposes the two ellipses that form its rim might be drawn alike. The points on the interior of the rim where the spokes are inserted can be projected from the elevation and carefully drawn within the ellipse after the hub has been located according to lines projected from the plan.

65. In drawing circles in perspective, no serious difficulty will be met, if they are always considered as polygons having an infinite number of sides drawn within a rectangle. Methods have been shown by which a rectangular surface, no matter what may be its inclination or position, may be easily drawn in perspective, and in the preceding problems the plans of the houses, the perspective elevations of their

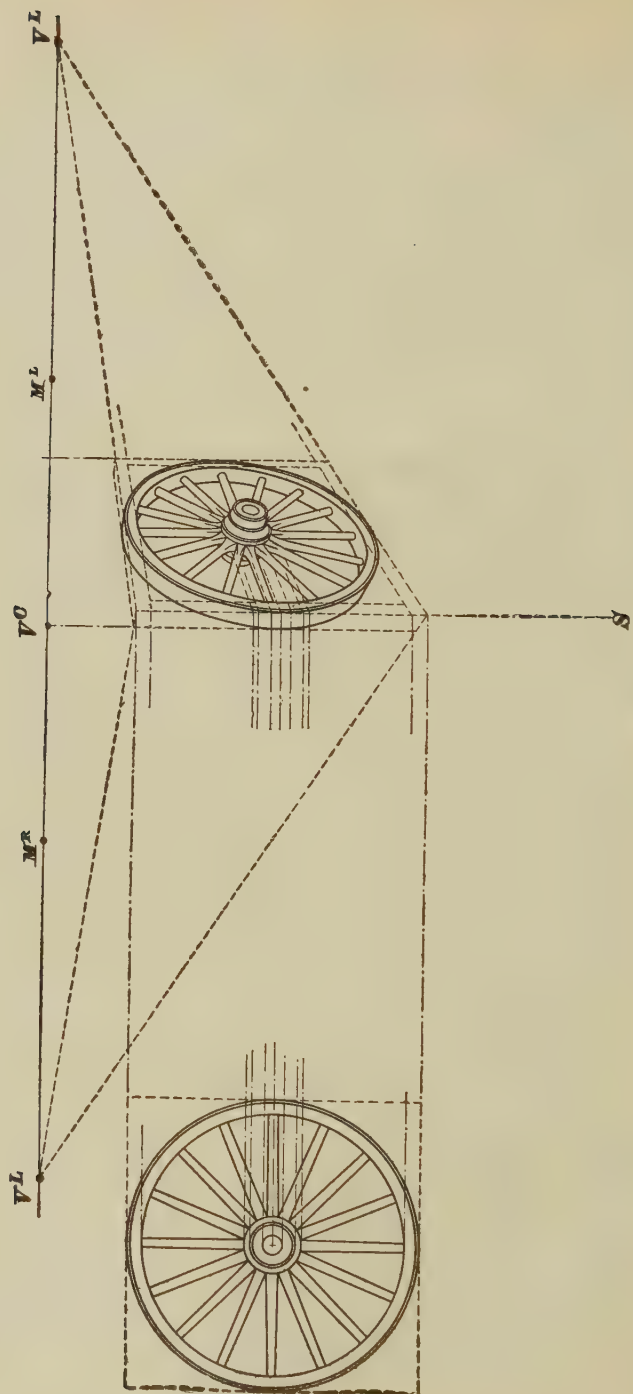


FIG. 49

sides, the surfaces of their roofs, etc. all represent rectangular surfaces in different positions and at different inclinations.

Any square can be drawn in a similar position, and when once projected in perspective it is a simple matter to convert the square into an octagon by locating on its sides the points in perspective where the extra sides of the octagon will intersect. These sides may be again divided into four parts, and, from the extreme part on each side, lines may be drawn converting the perspective of the octagon into a figure having sixteen sides, which in the majority of cases will be so near a circle that it will require simply a gentle curving of the lines in order to produce the ellipse that represents the circle in perspective.

66. Laying Out Circles.—It is frequently convenient to lay out these circles on a separate piece of paper, and having perfected the ellipse that represents one circle in perspective, to trace it off and transfer it to the drawing where it is required. For instance, in Fig. 50 (*b*) is shown what might appear to be a globular cage or basket composed of eight circles sprung together in zones. To lay out all the construction lines necessary to draw this figure would confuse the drawing very materially; therefore, it is more convenient to lay over the perspective rendering a piece of paper and to draw separately thereon each ring or ellipse; having perfected which, it may be traced and transferred to the final drawing, in order to produce the finished result.

67. Fig. 50 (*b*) consists of three vertical circles and five horizontal circles, the vertical circles all being the same size, but the horizontal circles being of three sizes according to their positions on the sphere. At (*a*) is shown the elevation of one of these vertical circles enclosed within the dotted square, on which the positions of the horizontal circles are also shown by means of the lines *ab*, *cd*, *ef*, etc.

In order to represent this figure, the cube $l'm'n'u's't'$ is first drawn, and on its edge $o's'$ is located the point f' half way between o' and s' ; $f'e'w'v'$ will then be a square

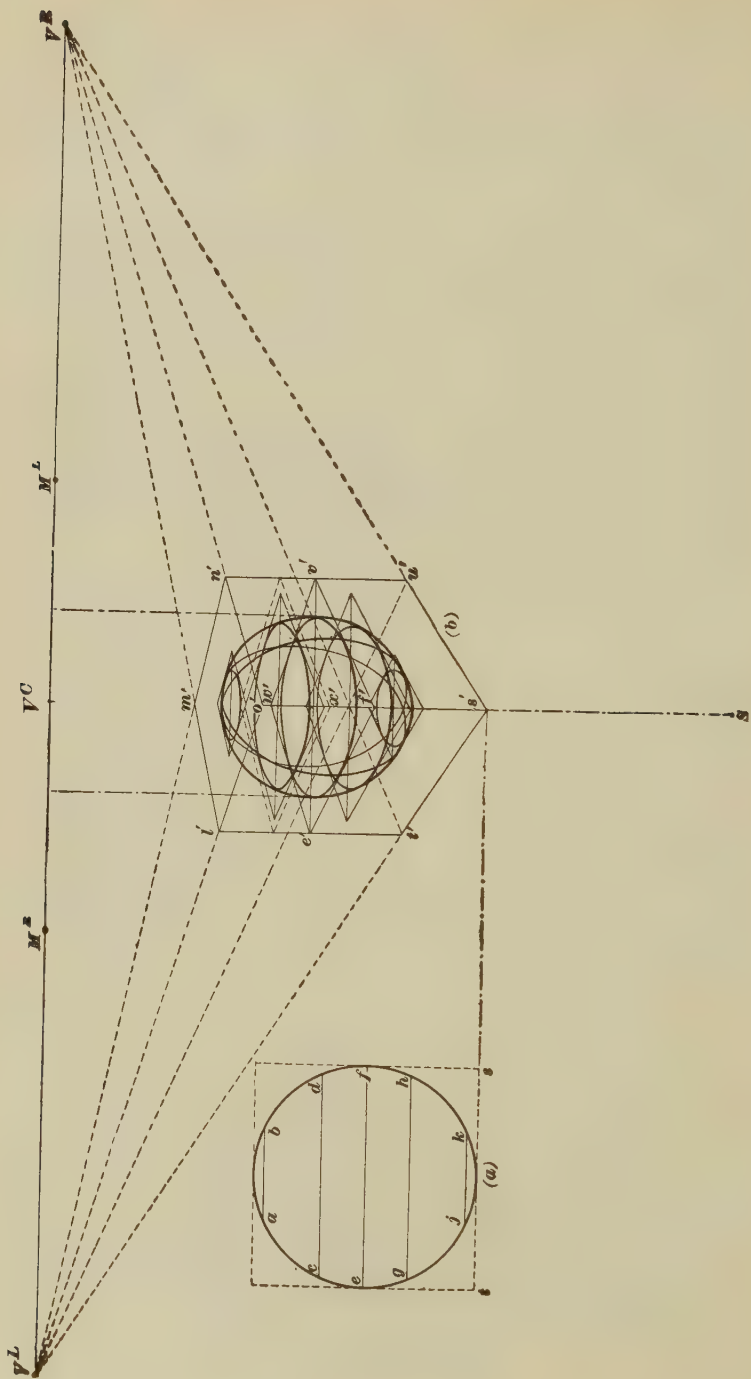


FIG. 50

containing the largest horizontal circle ef . The other two circles, above and below, are then located in smaller squares that are drawn in their relative positions. To draw these, it is convenient at first to locate a large square immediately over $f'e'w'v'$, the corner of which touches the edge of the cube $o's'$ at x' , which is a point on a level with the circle cd , as shown in the elevation (a). The smaller square containing the circle cd may be then drawn, as shown at (b), and the other circles located in their relative positions in a similar manner. In doing this, the perspective of the squares containing the ellipses are all that need be shown on the original drawing. These can then be redrawn on a separate piece of paper, and the ellipse sketched in, and, when perfect, traced in its proper place on the perspective drawing, as shown.

PRACTICAL PROBLEMS

68. The following problems are for practice, and need not be sent in as exercises except where expressly directed to do so. The problems are introduced to illustrate practical applications of perspective drawing in its several phases, and the construction lines are left in each case so that the problems may be worked out for practice if so desired; or they may be referred to as a guide to similar problems as they present themselves.

PROBLEM I

69. In Fig. 51, two views of an octagonal prism are shown, one above the horizon and the other below it. The square containing the octagonal base is $2\frac{1}{2}$ inches on each side, and therefore, on the measuring line AB , $2\frac{1}{2}$ inches is set off from a to b each way, and ad and bc are laid off equal to one-half the diagonal of the square, so as to divide ab in the proportions of the side of a square and enclosed octagon. The vanishing points V^L and V^R are 20 inches apart, and lines drawn from b , c , and d toward the measuring points will intersect lines drawn from a toward the vanishing points,

so as to lay out the octagon, as shown. The height of the prism, or its distance above or below the horizon, is immaterial in this problem, and these details may be arranged in any satisfactory manner. The prism may also be placed to the right or left of the center of vision somewhat if desired. The drawing is to be made on a sheet of $9'' \times 12''$ paper,

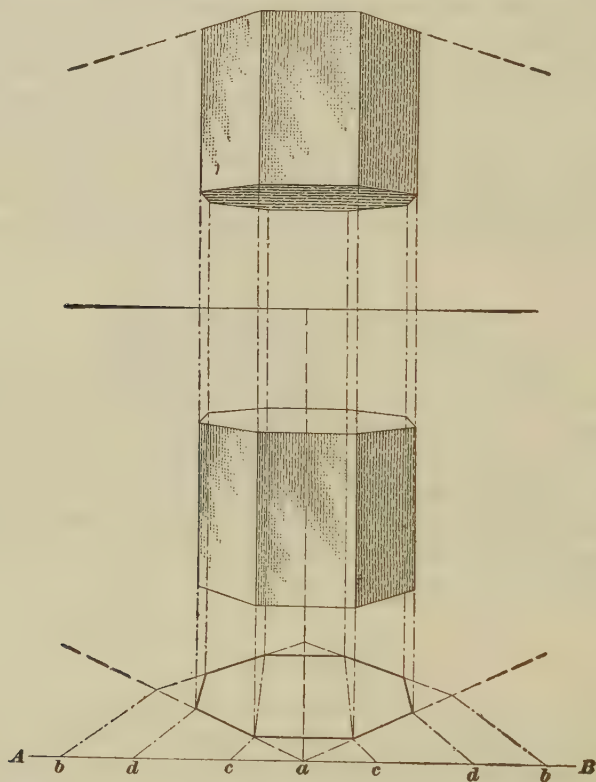


FIG. 51

with a $\frac{1}{2}$ -inch border as usual, but the problem will require a full-size drawing board.

For the drawing of this and successive problems, it will be well to draw in ink on the drawing board a line representing a horizon, on which is located at the proper places the center of vision and measuring points. In making a perspective

drawing at any time thereafter, two pins may be inserted at the vanishing points, and with the edge of the T square

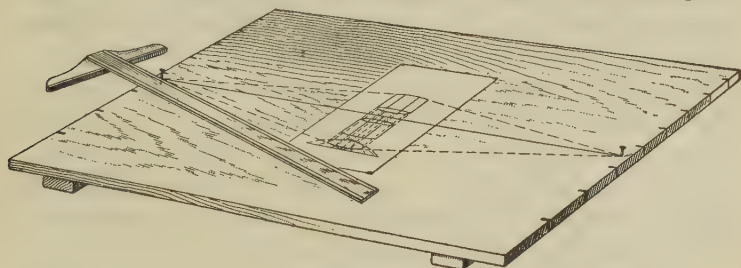


FIG. 52

working against them, problems may be solved on smaller sheets placed at the proper places (see Fig. 52).

PROBLEM II

70. Fig. 53 shows a flight of steps. These steps are each

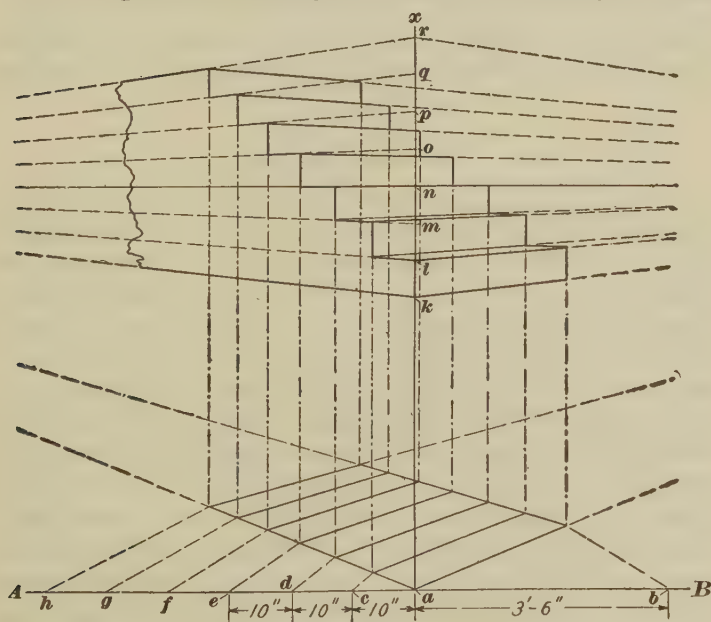


FIG. 53

6 inches high and 10 inches wide, and their width is 3 feet

6 inches. In laying out the perspective plan, ab is laid off on the measuring line AB equal to 3 feet 6 inches, the width of the steps, and a, c, d, e, f, g , etc. are each laid off 10 inches, representing the width of each step. Lines drawn from these points to the measuring points will intersect with lines drawn from a to the vanishing points, and will give the points from which the perspective plan of the steps can be drawn. The vertical line ax can then be drawn from a , the point where the perspective plan touches the measuring line, as the line on which the vertical measurements are to be determined, and the points k, l, m, n, o, p, q , and r are then laid off 6 inches, each representing the height of each of the risers. Lines drawn from these points to V^L will determine the height of each riser, and the perspective width of the tread can be projected up from the plan as shown.

Draw the perspective plan and elevation of these steps, as shown in Fig. 53, at a scale of $\frac{3}{4}$ inch to the foot, and use $9'' \times 12''$ paper with a border line $\frac{1}{2}$ inch within the margin.

PROBLEM III

71. In Fig. 54 is shown a bookcase, the front and side elevations of which are illustrated in Fig. 55. The perspective plan of this bookcase is drawn out as shown in Fig. 54. Some complication may arise here, as the measuring line is drawn through the corner of the case itself, whereas the top of the bookcase projects 1 inch on three sides. In laying out the plan, the distance ab is laid off 2 feet on this measuring line the entire width of the bookcase, and a, c, d, e and b, c, d, e are laid off 1 inch each to mark the thickness of the ends of the case, the width of the bottom of the foot and the width of the top of the foot, being 1, 2, and 3 inches, respectively. At e, f, g, h , etc. are laid off the widths of the books on the lower shelf—2 inches each. Lines drawn from these points toward the measuring point M^R will intersect a line drawn from a toward the vanishing point V^R and enable the perspective plan to be constructed.

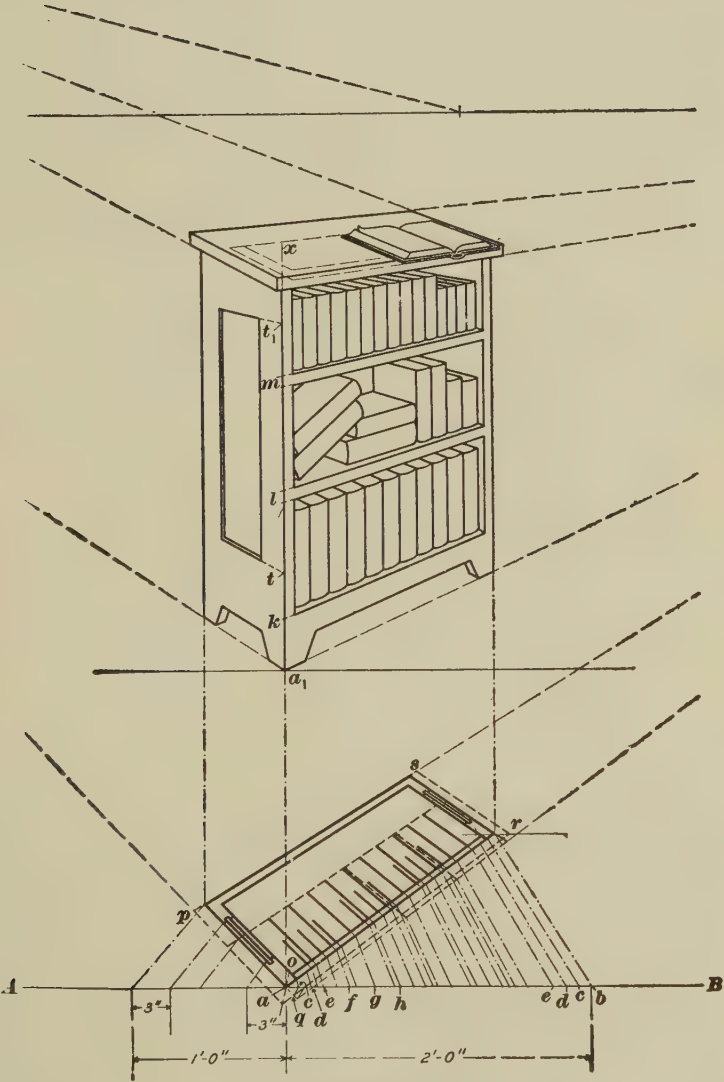


FIG. 54

The corner of the case shown in the elevation a, x has marked on it, according to scale, the heights of the lower shelves at k and the thickness and position of the two other shelves at l and m . These are projected across the case toward V^R , and located in their proper places. The inclination of the top and its projection over the sides is found by drawing the line from V^C through a , as indicated on the plan by the line ao . This is the diagonal of the corner. The projection of the top of the bookcase is 1 inch; in other words, it projects beyond the end of the case the distance ac .

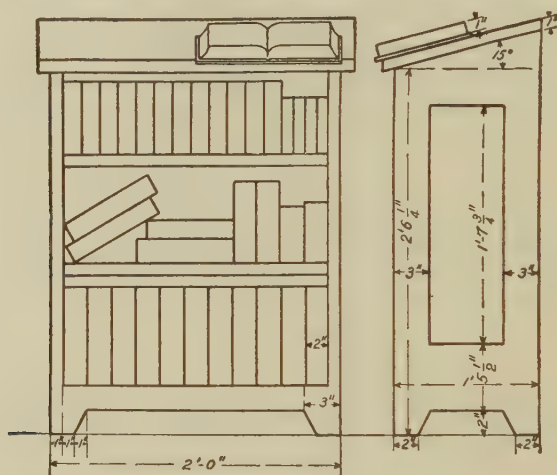


FIG. 55

If, therefore, a line is drawn from M^L through c until it intersects with the side of the case prolonged, as from a to g , it will mark this projection. A line drawn through g toward V^R will show the projection of the top over the front of the case, and where this line intersects, the line ao will show the projection as it returns around the end of the case. This projection should be indicated by a dotted line drawn toward V^L to p and toward V^R to r , where it will intersect a horizontal line through the corner of the case and then return toward V^L to s . The width of the end is found by laying off 1' 0" from a toward A on the measuring line, the panel being

indicated by laying off its width between these points, as shown. The height of the panel and its position above the floor is indicated by locating on a, x the points t and t_1 , according to measurements shown in Fig. 55. The inclination of the top will be indicated by finding the vanishing point of the inclined plane of which the top is a part. From M^L , at an angle of 15° to the left, a line is drawn locating a vanishing point directly over V^L . This will be the vanishing point of lines at 45° with the horizon and inclined upwards 15° , and lines drawn toward this point from the corners of the top projected from the plan will locate the position of the top in the elevation. The position of the books on the lower shelf should then be drawn in from the plan and indicated as shown, about 1 inch inside of the edge of the shelf. Now, draw the upper-shelf books in the plan, each of the larger books being $1\frac{1}{2}$ inches thick and each of the smaller ones 1 inch thick.

All the details have now been completed except the drawing of the open book that lies on the top of the bookcase. The outline and center fold of this book should be carefully drawn in the plan, Fig. 54, by laying off the required width from b toward a on the measuring line AB and projecting lines to M^R , as shown by the dotted lines. It will be observed in the elevations, Fig. 55, that the front edge of the book projects over the desk somewhat, and that the right-hand end is about even with the vertical side of the case. The projection of this book may be determined in the plan by laying off a distance to the right of a on the line AB equal to the projection, and drawing a line from M^L through this point until it meets the end of the bookcase prolonged. A line from this point of intersection to V^R will give the required projection. The width of the book, as shown in the side elevation, Fig. 55, may be found by laying off the distance to the left of a on the measuring line AB , and projecting a line to M^L until it intersects the line from a to V^L . This is shown in the plan, Fig. 54.

The thickness of the open book should now be laid off on the line a, x as it would appear if in contact with the picture

plane, and lines from V^N 15° through these points should be prolonged to meet a vertical line from the projection of the book in the plan. Lines from these points to V^R will give the front and lower edge of the bookcover. The edges and center may now be projected from the plan to meet these lines, and the leaves and center fold indicated by lines from the points of intersection to V^N 15° . The width of the book should then be projected from the left side of the plan to the top of the case and then to V^R , as shown. The leaves may be rounded in toward the center freehand, as projected up from the plan, and the concave edges of the outer leaves may also be sketched freehand.

In working out this problem, the corner of the bookcase should be $1\frac{3}{4}$ inches to the left of V^C , the point a , $5\frac{1}{2}$ inches below the horizon, the vanishing points 20 inches apart, and the bookcase drawn on a scale of $1\frac{1}{2}$ inches to the foot.

PROBLEM IV

72. Problem IV presents a simple rush-seated chair with a slat back, as shown in Fig. 56. It may be drawn on a scale of $1\frac{1}{2}$ inches to the foot, and in the illustration the point a is $5\frac{1}{2}$ inches below the horizon and $2\frac{1}{2}$ inches to the left of V^C . The square within which the four legs and seat are shown in plan is 15 inches on each side. The diameter of the turned legs is $1\frac{1}{2}$ inches, so that these can be laid off at each corner of the square. The height to the top of the front legs ab is 14 inches, and to the seat is 13 inches, thus showing that the legs project 1 inch above the seat in front. The height of the back legs continued up to form the chair back is 33 inches, which distance is laid off on the line ax , locating the height at y . Lines drawn from a and y to V^L will then determine the proportions of the back leg. The positions of the back slats are also laid off on the line ax , as shown at vw , and below, and their dimensions projected to the chair back by lines to V^L , as shown at ut . Lines from ut to V^R show the position of the slat across the back of the chair. Other details are similarly located.

The whole chair may be detailed accurately according to

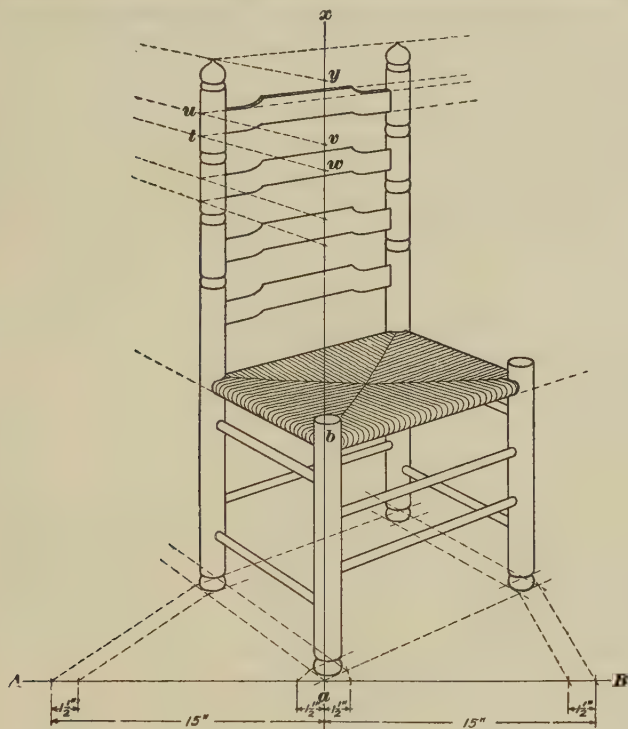


FIG. 56

measurement if so desired, or the principal lines may be located as just described and the sketch finished up freehand.

PROBLEM V

73. In Fig. 57 is shown another chair similar to that in the preceding problem, but not so uniform in its outline. This chair is 16 inches in front and 16 inches deep from front to back, but tapering so that the full width at the back is only 12 inches at the seat and 10 inches where the legs touch the floor. In drawing this chair in perspective, ab and ac are laid off 16 inches each, and lines are drawn from the points b and c toward the measuring points until they

intersect lines drawn from a toward the vanishing points. In this way, the rectangle containing the entire seat plan can be laid out. The legs of the chair where they rest on the floor are 1 inch square, and therefore ad and ce are laid off 1 inch, to mark the perspective width of the front legs, and af and cg are laid off 3 inches each from a and c , so as to make the distance gf 10 inches—the outside measurements across the back legs where they rest on the floor; ch and aj are

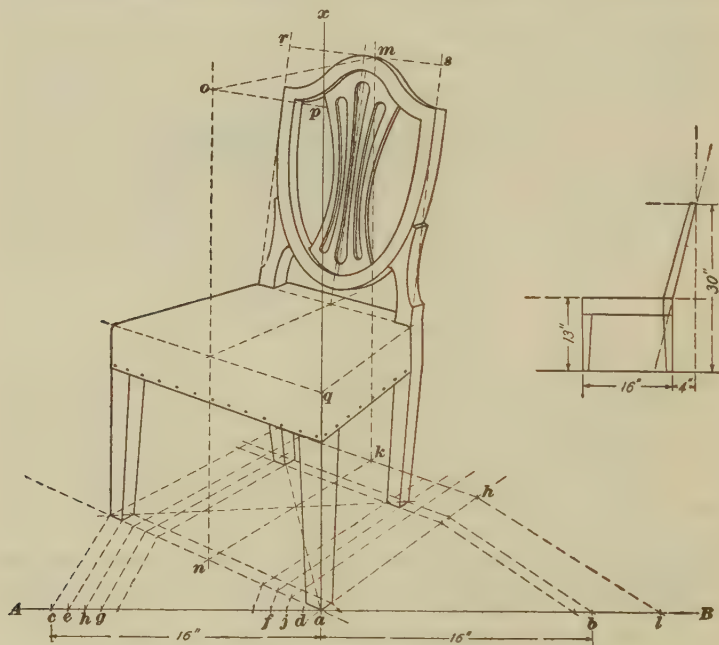


FIG. 57

then laid off 2 inches each, so as to make the distance hj 12 inches—the width of the seat of the chair at the back. Now, these points can be projected from the line ac to the perspective side of the rectangle containing the seat by drawing lines toward M^L , and those for use in the back can be again projected as required toward V^R . The 1-inch square representing the base of the foot should be drawn in the plan, and the legs should be drawn into the seat line as

shown, gradually extending to give the taper required. In accurate work, the width of the legs could also be laid off and projected to the top, giving the exact taper, but under general conditions this can be judged by the eye. The back of the chair is not perpendicular, as was the case in Fig. 56, but inclines so as to overhang at the top 4 inches, and the amount of this overhanging can be laid off from *b* to *l* and projected as shown. The rectangle enclosing the back of the chair can then be drawn in its proper position, and the ornamental figure can be sketched within it accurately. The balance of the work is entirely freehand.

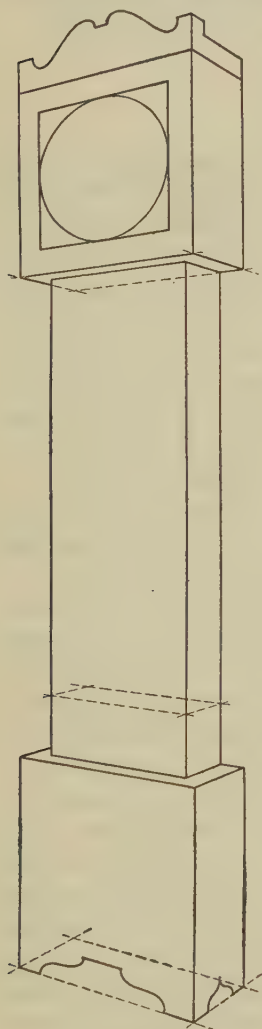


FIG. 58

PROBLEM VI

74. There is nothing new in Problem VI, but it is introduced simply as a suggestion, showing the simplest way of working. The plan on the floor, as shown in Fig. 58, is drawn directly at the base of the old clock case itself, whereas the plan of the middle section is drawn just above the lower section, and the plan at the top is drawn at the base of the top. In this way, the plans can all be erased when they are no longer required, and the details of the clock can be sketched in almost entirely freehand. Pieces of furniture of this character can thus be rapidly introduced into perspective interior with-

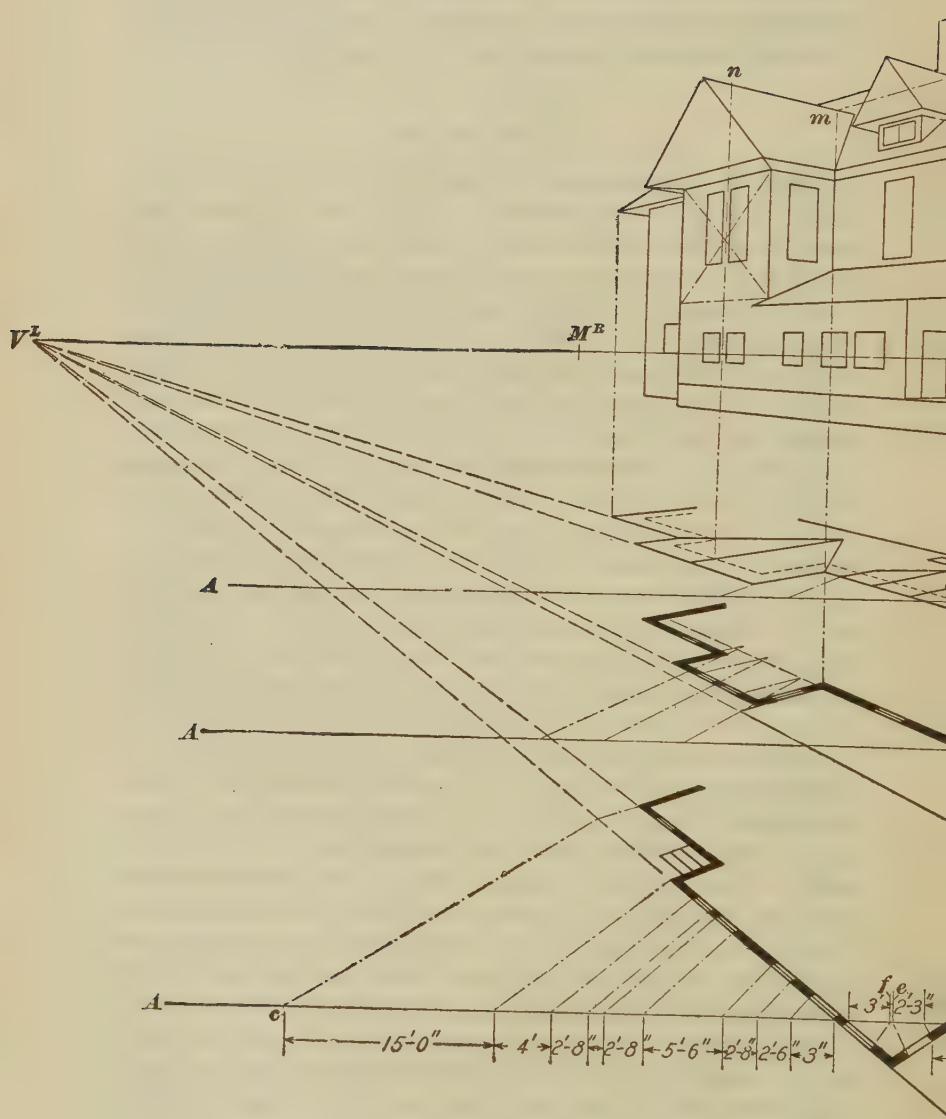
out going through a long preliminary operation of finding absolute vanishing points. In fact, for general work, the

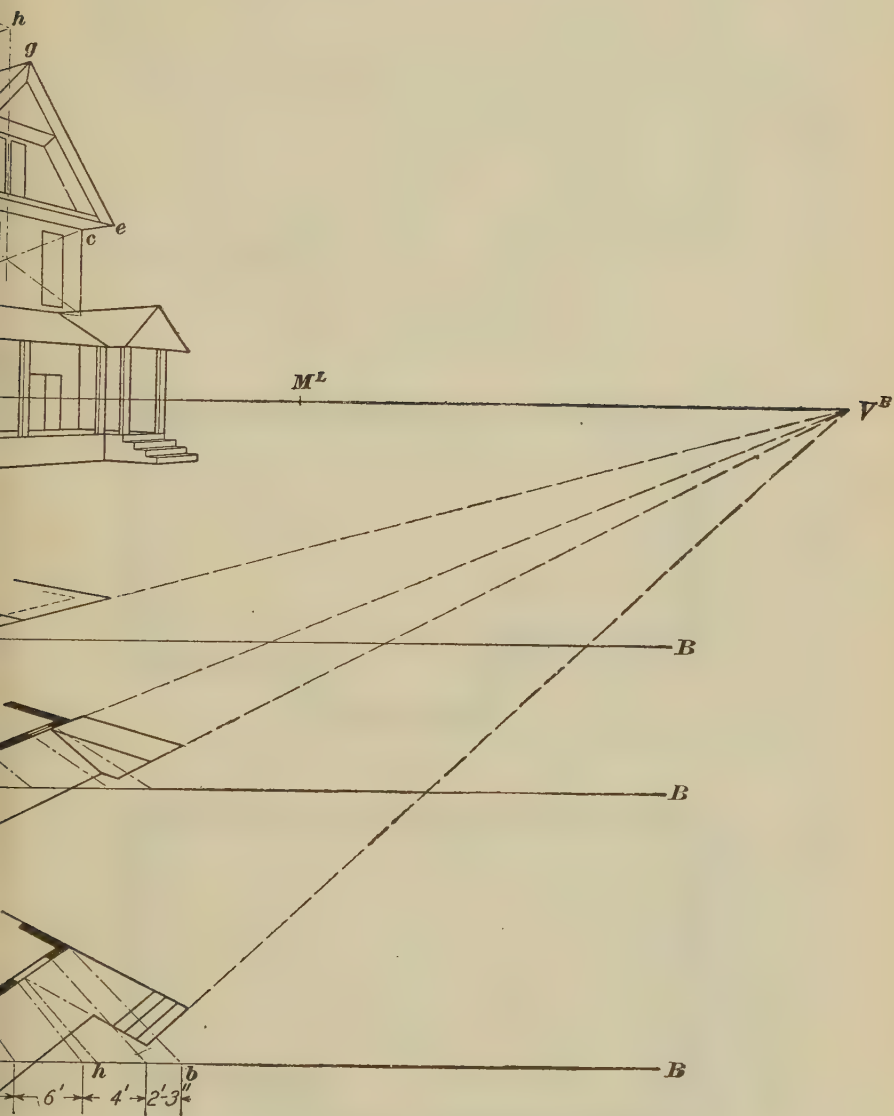
whole perspective can be suggested freehand and the vanishing points assumed afterwards in such a position as to give the desired effect, and the whole drawing worked up accurately according to the preliminary freehand sketch.

PROBLEM VII

75. In Problem VII is given the application of the principle stated in Art. 74, in a house plan, where the three stories of the house present different complications in plan. The orthographic projection of the plans is shown in Fig. 59, where (*a*) is the first-story plan; (*b*), the second-story plan; and (*c*), the roof plan drawn to a scale. In making a perspective, the line of measures may be placed in contact with the plan at the angle of the second story *a* or the angle of the first story *a'*. The former is deemed preferable, as it keeps some part of the building in contact with the line of measures throughout the perspective drawing, as shown in Fig. 60.

In the second story, on the line of measures *AB*, Fig. 60, the corner of the building is fixed at *a*, and the perspective plans are worked out according to the two visible sides of the house. The first-story plan then shows a portion of the building extending beyond the measuring line, which may introduce a few complications in the projection but presents no difficulty, whereas if the corner of the first story at *a'*, Fig. 59 (*a*), had been placed in contact with the measuring line, it would have thrown the corner of the second story away from the line and out of the plane of measures. From *a* to *b* in the first-story plan, all the measurements for the house front are laid off on one side, and from *a* to *c* the measurements for the side elevation. Immediately over this and in the proper position, the second-story plan is also laid out. Now, on the front is shown one window and on the side one window, which are thrown in front of the picture plane, as well as is the corner of the house. From *a*, therefore, to *f* and *e* are laid off the locations and distance of the front window and corner, and from *M^R* a line through *e* locates this window in relation to the corner of the building.





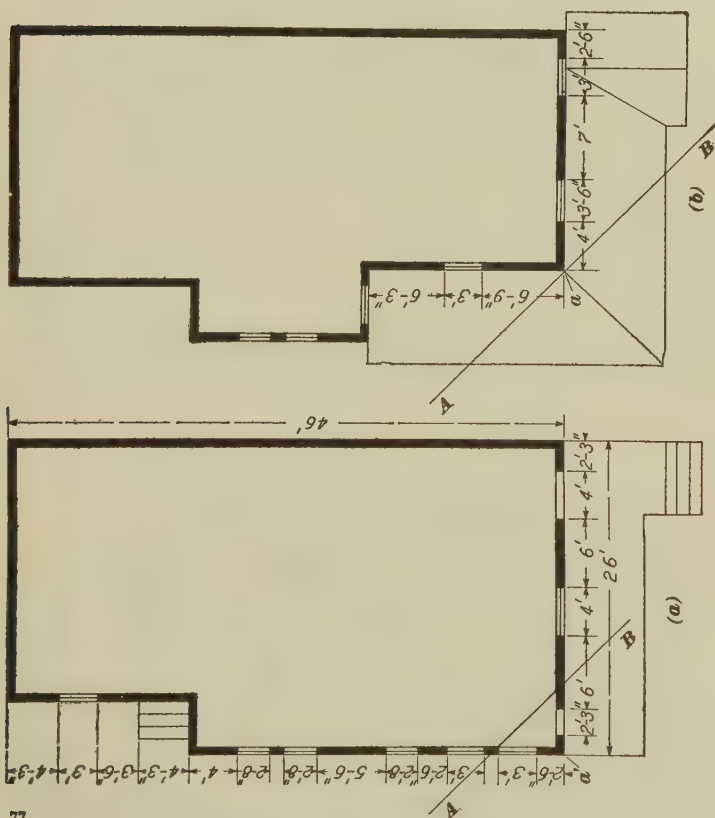
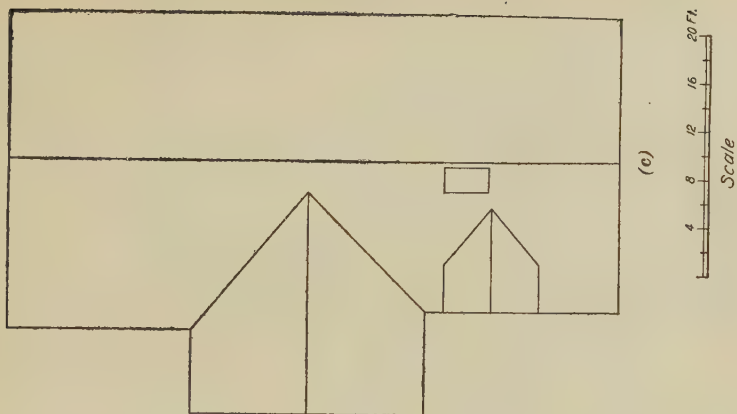


FIG. 59

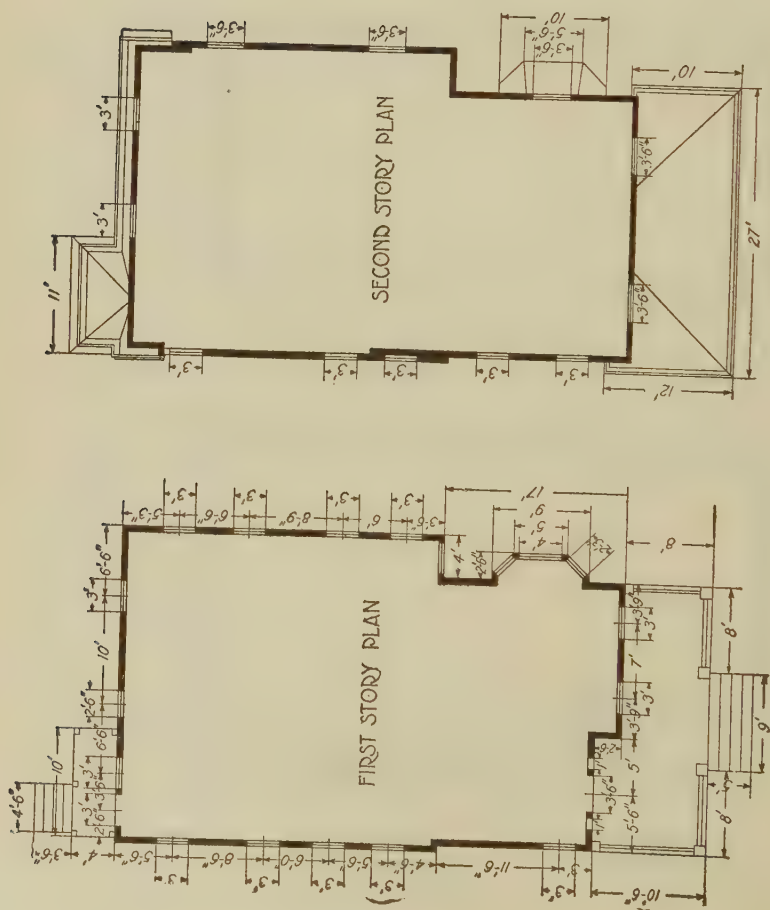
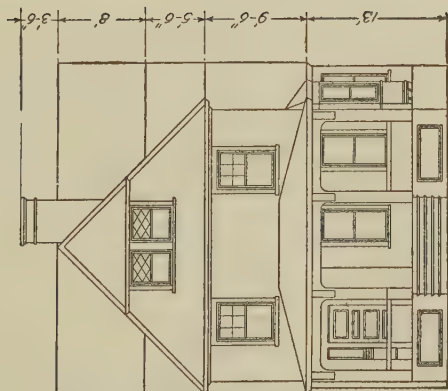
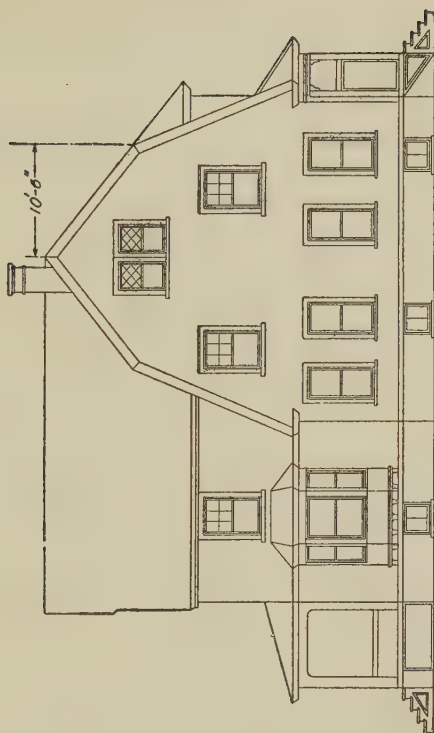


FIG. 61



FRONT ELEVATION



SIDE ELEVATION

FIG. 62

In a similar manner, other points may be located for the window on the side, and the details of the windows projected in the perspective elevation. The completion of the elevation consists simply in laying off the proper heights and proportions of these details on the measuring line ax , and taking their perspective widths from the projection of the plan.

PROBLEM VIII

76. In Fig. 61 is shown another set of plans for a simple house, the roof of which is of a different type, as shown in Fig. 62, and requires more careful study in the location of its different points. Fig. 63 shows the rendering of this house in perspective, as well as its appearance when the perspective sketch is complete. The construction lines in the plan are all left in place, and a comparison of the dimensions with Fig. 61 will show the purpose of each. The corner of the building is used as a line of measures in the elevation, and is in contact with the line of measures in the perspective plan. This brings the porch and steps in front of the line of measures in the plan without complicating the problem or rendering it difficult to carry out. Fig. 64 illustrates the shading of the perspective after the sketch has been worked out in pencil according to the perspective measurements.

PROBLEM IX

77. It is sometimes necessary and desirable to render a building somewhat more rustically than the foregoing, or to use perspective drawing in connection with a subject that is more pictorial in character. In Fig. 65 is shown a photographic illustration of the Parthenon, at Athens, in its ruined condition. To reproduce this on a larger scale in perspective, it is first necessary to draw a plan, such as is shown in Fig. 66, where all the details of the building are expressed without indication of ruin. Use scale $\frac{1}{16}'' = 1'$. This plan, or its dimensions, can be used in laying out a perspective plan, such as is shown in Fig. 67, and from the perspective plan the perspective elevation can be projected in its completed condition,

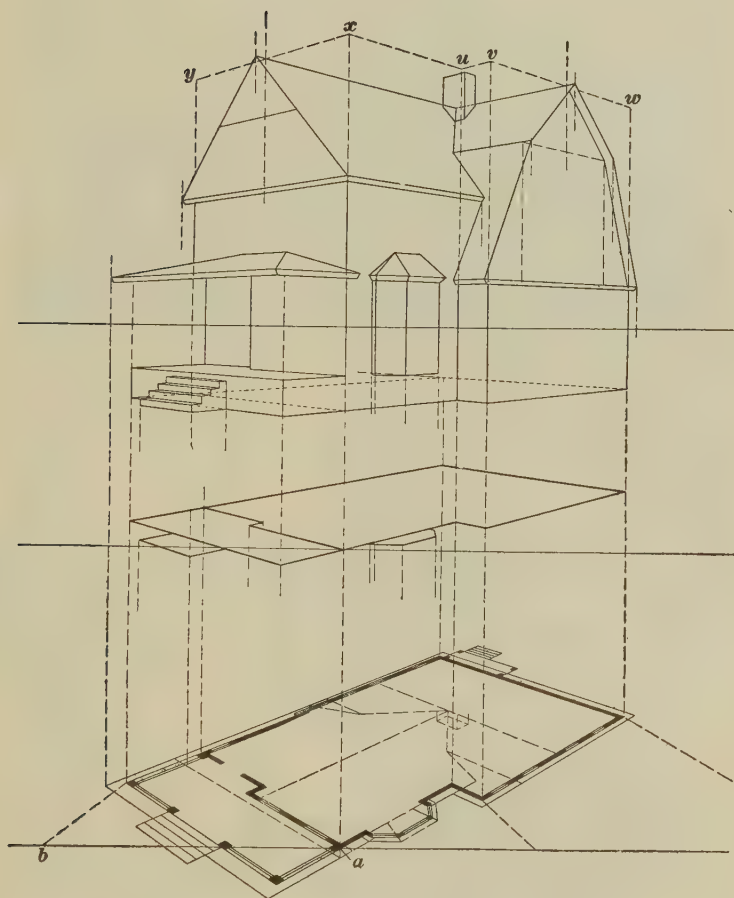


FIG. 63

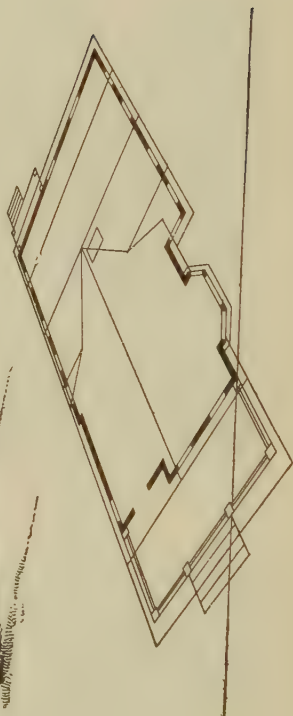


FIG. 64



FIG. 65

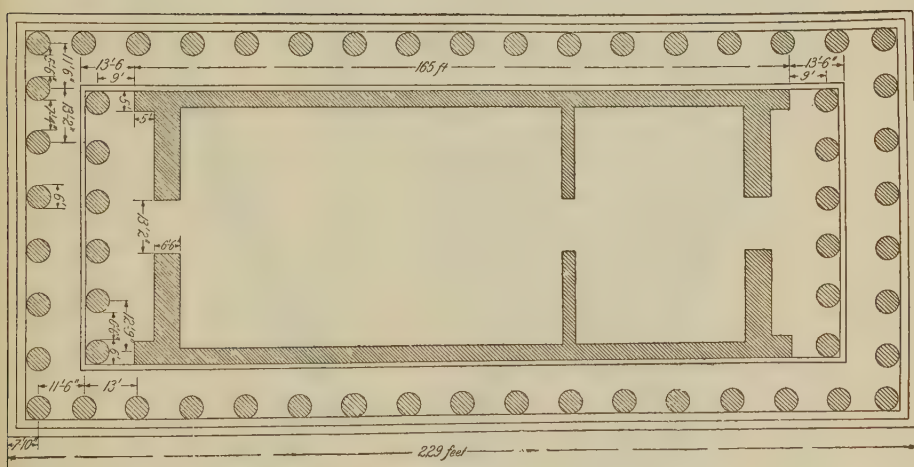


FIG. 66

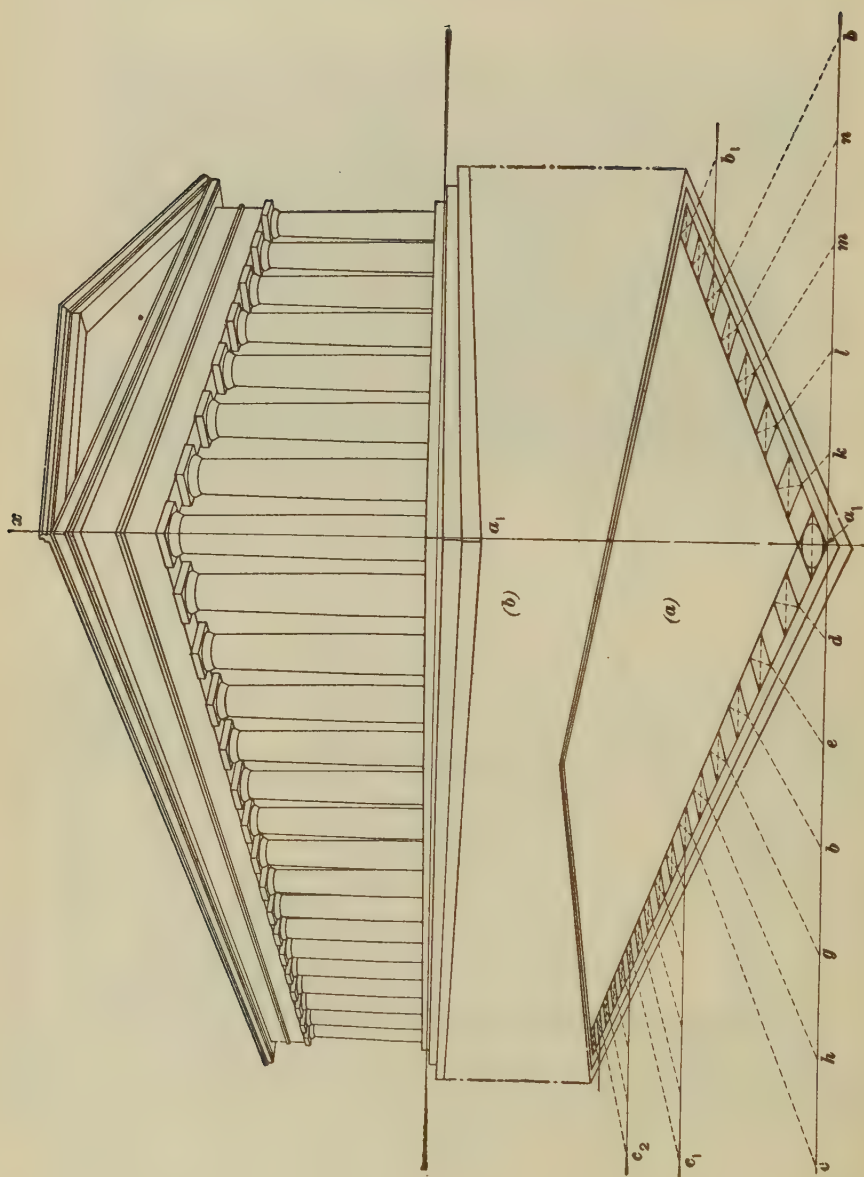


FIG. 87

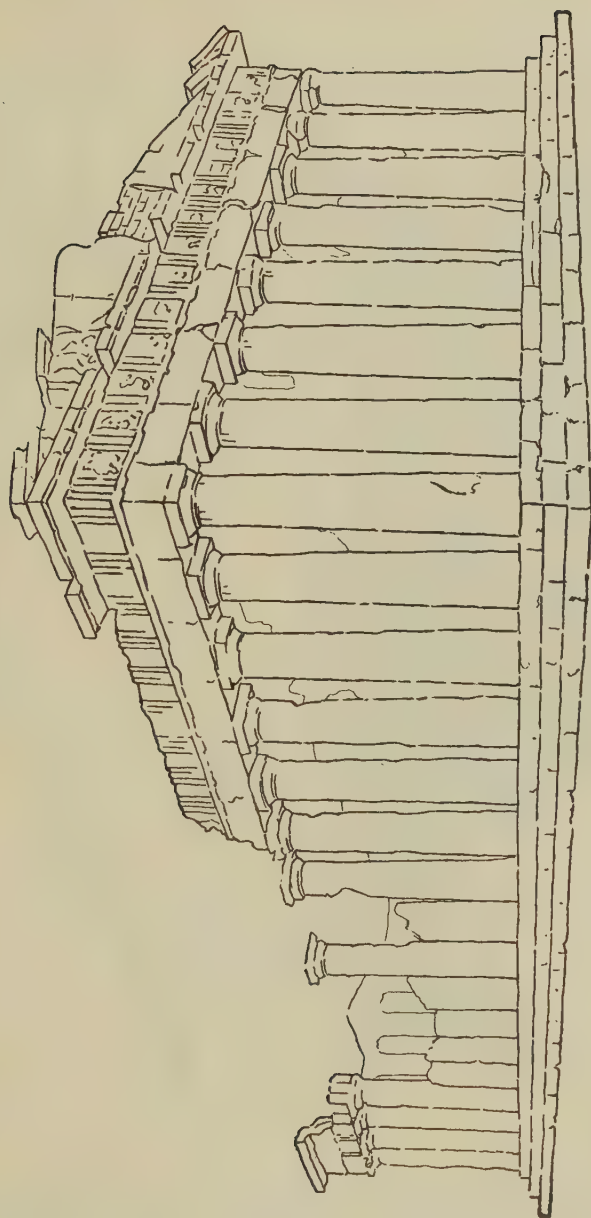


FIG. 68

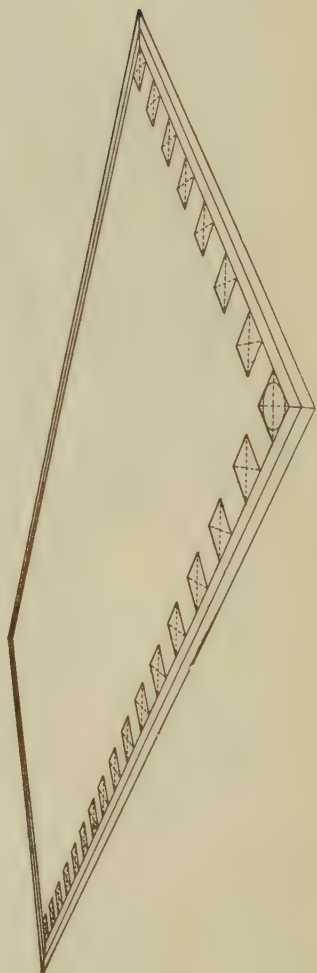
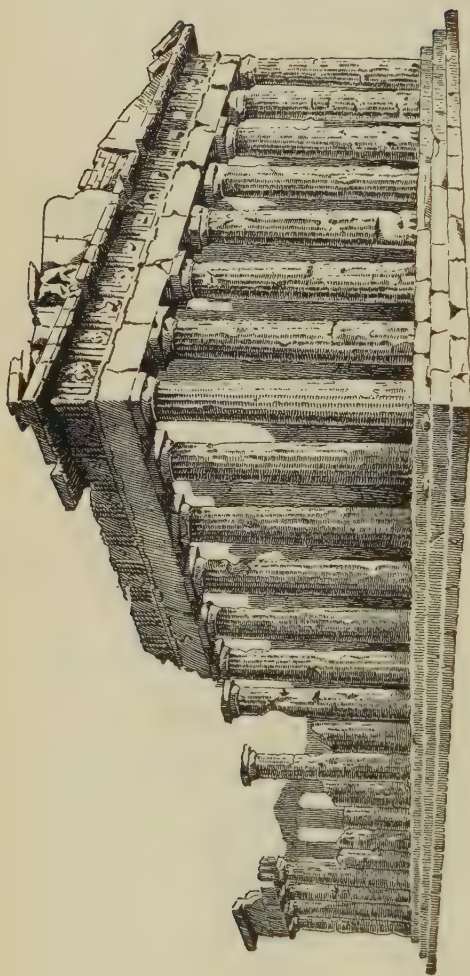


FIG. 69

as shown. It is not necessary that the ellipses representing the plans of the columns be worked out entirely, as a straight line representing the diameter of the column at the bottom is all that is necessary. The rest can be done by eye measurement, and when the perspective elevation is completed, as shown in Fig. 67, the removal of certain portions to represent its ruined condition and the treatment of the details can be carried out in outline, as shown in Fig. 68. The drawing in this condition is ready to ink in for a pen-and-ink study, as in Fig. 69, to color in for a water-color study, or to shade up in pencil for a finished pencil study, but in any drawing it is necessary first to complete the perspective in outline to show the general conditions.

78. In the foregoing examples, it was necessary only to sketch in freehand the outlines of the capitals and moldings

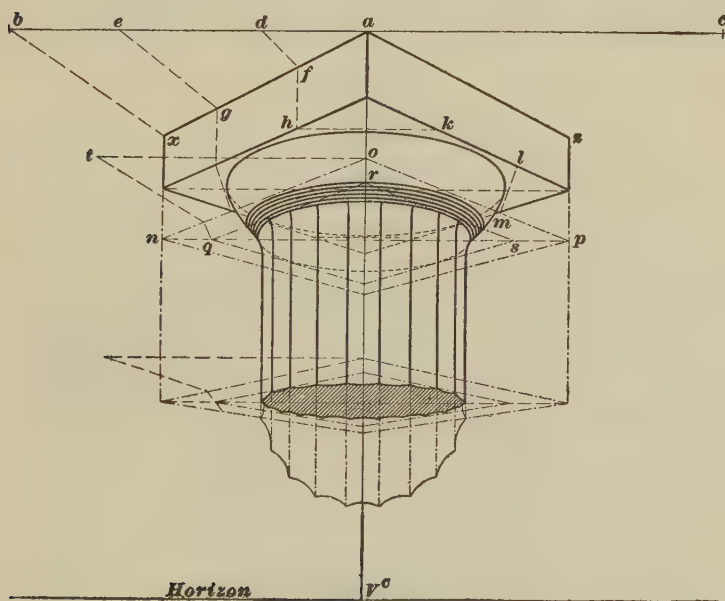


FIG. 70

of this architectural subject, but occasions may arise where these details are so large that it is desirable to work them

out with greater accuracy. In Fig. 70 is shown the Doric capital and the method of getting its proper perspective.

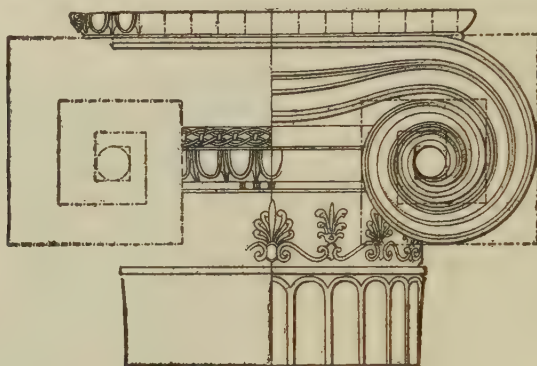


FIG. 71

The measuring line *bac* is drawn at any convenient point above the horizon, and the measurements of the details of

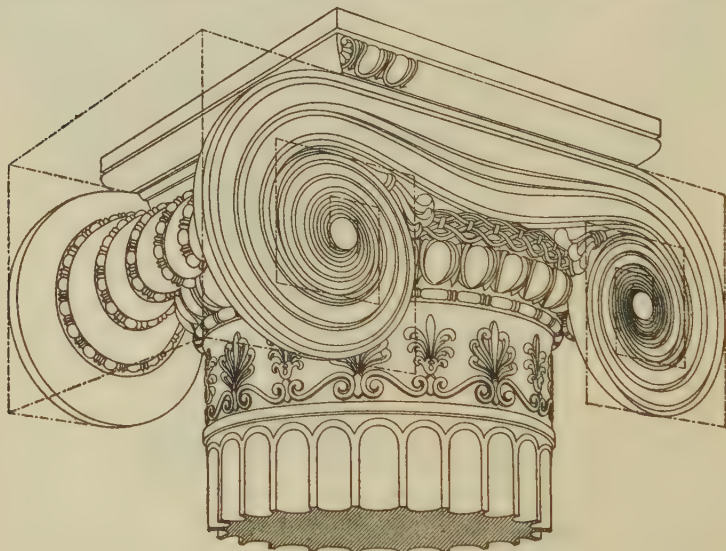


FIG. 72

the capital laid off from *a* toward *b* and *c*, the distances *ab* and *ac* each being equal to the side of the abacus, and the

intermediate distances being laid off to determine the sizes of the smaller squares within which circular annulets are drawn. The flutes on the column may be projected from the perspective plan of a regular sixteen-sided figure if it is so desired, but for all practical purposes a circle may be drawn and divided into the required number of parts, and these parts projected directly. The latter method is not strictly accurate but is sufficiently so for all practical purposes.

79. In drawing the Ionic capital, vertical curves are called into existence. The diagram, or volute, is laid out in its proper proportions, first, by straight lines, as shown in Fig. 71. This form is then drawn in perspective, as shown in Fig. 72, and the scroll sketched in freehand.

The Ionic base is not easy to express accurately in perspective. The best way to do it is to make a perspective drawing of the plinth, either in 45° perspective, as in Fig. 73,

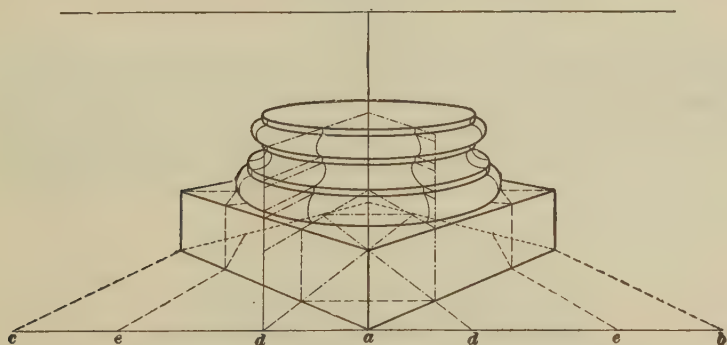


FIG. 73

or in parallel perspective, as in Fig. 74. In the latter, only one side of the plinth and a portion of the top are seen, while in Fig. 73 two sides and a portion of the top are visible. The top of this plinth should be divided so as to represent an octagon in perspective, and on the diagonals of this octagon perspective views of the profiles of the base, as shown in Fig. 75, should be drawn. First, draw the elevation

of the profile of the base, as in Fig. 75; then, draw the perspective of this profile in different positions, as in Fig. 74. Thus, when profiles extending from *a* to *o*, *b* to *o*, *c* to *o*,

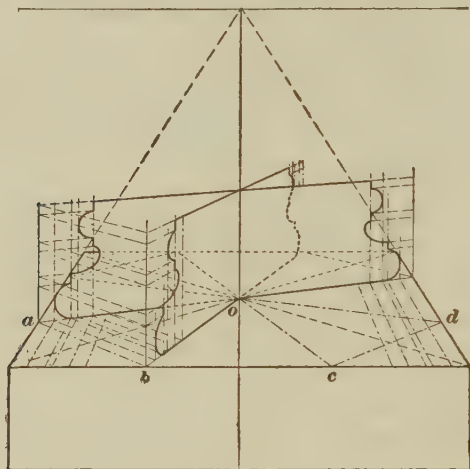


FIG. 74

and *d* to *o* are drawn, they can be united by carefully sketched curved lines, as in Fig. 73, so as to present a full perspective of the base. In making perspective drawings of circles, it is always best to consider them as exactly in

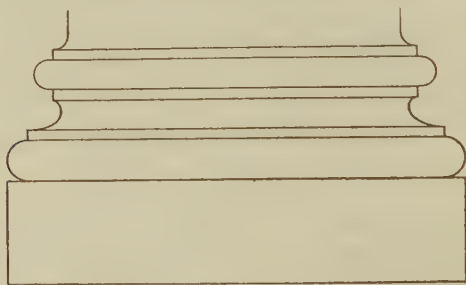


FIG. 75

the center of vision, for when they are moved far to the right or left, they are likely to become distorted unless the drawing is so held that the object shown appears at its

proper distance to the right or left of the eye. Thus, in Fig. 76, the Doric capital looks very much out of proportion,

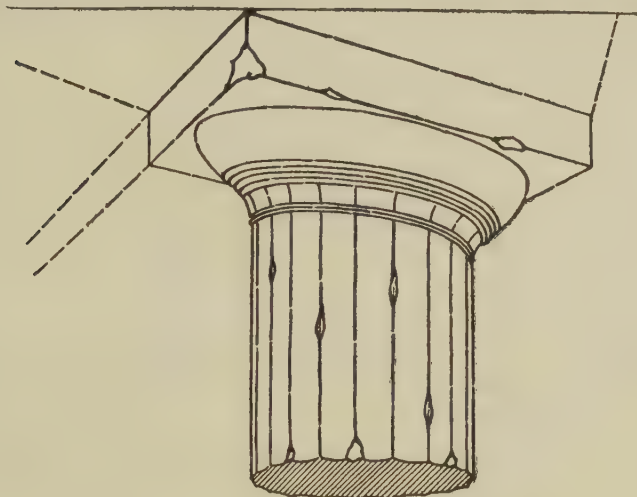


FIG. 76

owing to its being placed so far to the left, whereas if the circular portion of it, or top member, had been drawn as in its previous illustration, Fig. 70, this difficulty would be entirely obviated.

In Fig. 77 is shown an Ionic base, the plinth of which

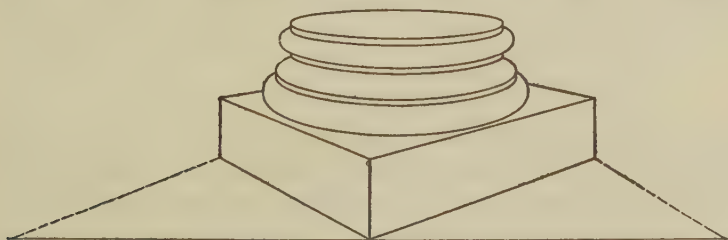


FIG. 77

shows that the detail is far to the left of the center of vision. The moldings, however, are drawn as though the base were directly in front of the eye, thus preventing all appearances of distortion.

Fragmentary pieces of columns can be drawn in perspective in either position with little regard to the general appearance of the polygons forming their tops, as these are

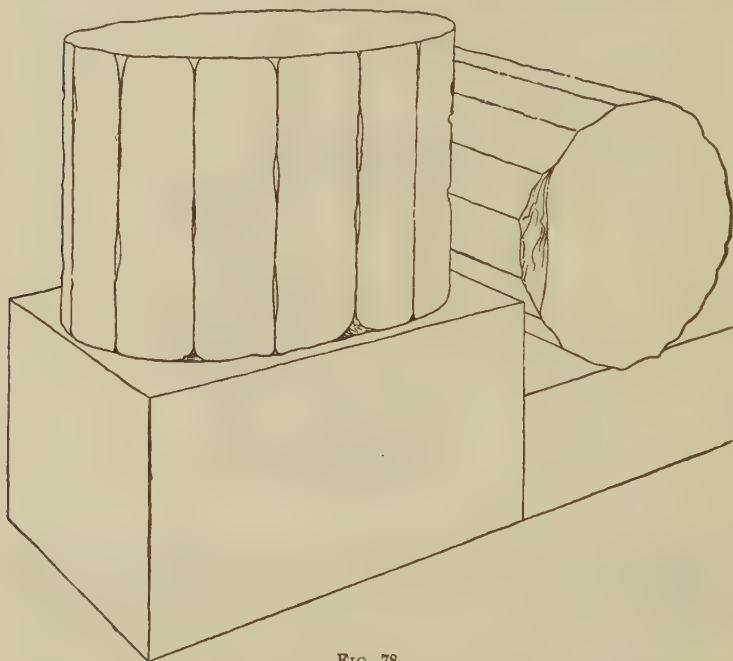


FIG. 78

likely to appear with broken edges, and the irregularity compensates what would otherwise be a distortion, as in Fig. 78.

PROBLEM X

80. Up to the present time, all the examples illustrated have been exteriors showing plans of buildings viewed from the outside. A problem of an interior showing the details of a room will now be taken up. In Fig. 79 are shown the plan and two elevations of a small room on which are indicated three pieces of furniture, one a bookcase, similar to that illustrated in Art. 71, and two chairs similar to that illustrated in Art. 72, the difference being that while the room is in 45° perspective the chairs are in parallel



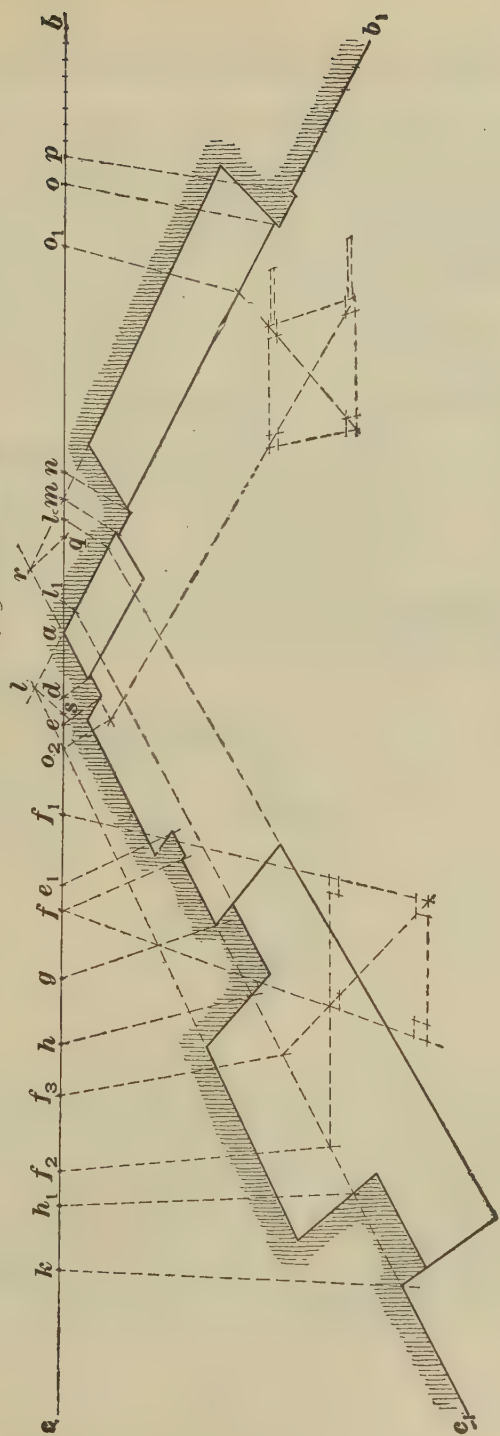
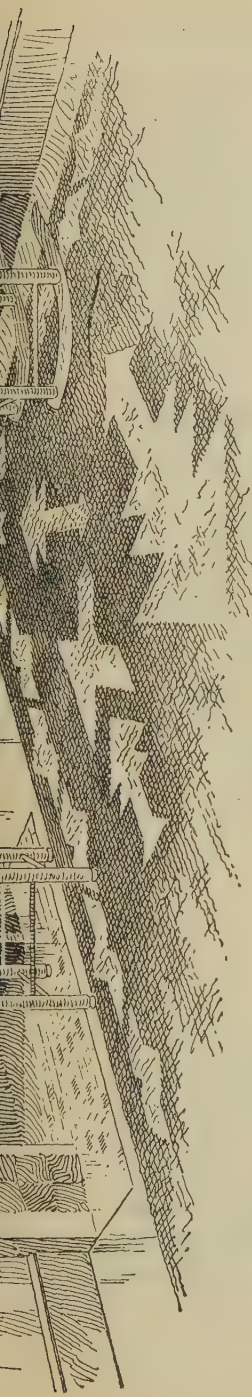


Fig. 80

perspective. In this case, the measuring line ab , Fig. 80, is laid off for dimensions on the right side of the room, and ac for dimensions on the left side. It will be observed that the entire plan is in front of or below the measuring line in this case, and on the line that vanishes at V^L the measurements laid off on it are from the measuring point M^L ; and,

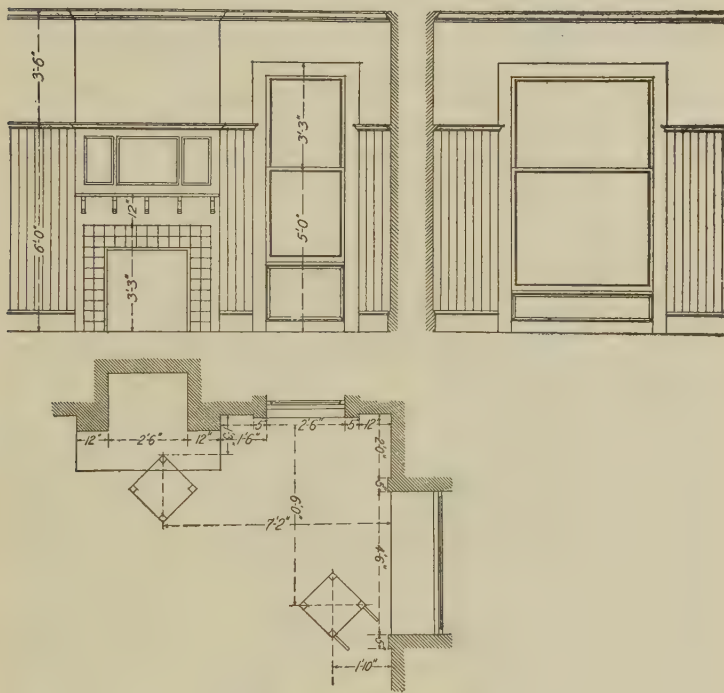


FIG. 79

on the contrary, the measurements laid off on ac are projected into the perspective plan from M^R because ac vanishes at V^R . The line ax going through the corner of the room serves as a measuring line on which all the details are laid off to scale, and are projected therefrom to their proper position in the sides of the room. It is evident from this that the details of the room will be larger than their scaled dimensions. A scale of $\frac{3}{8}'' = 1'$ may be used.

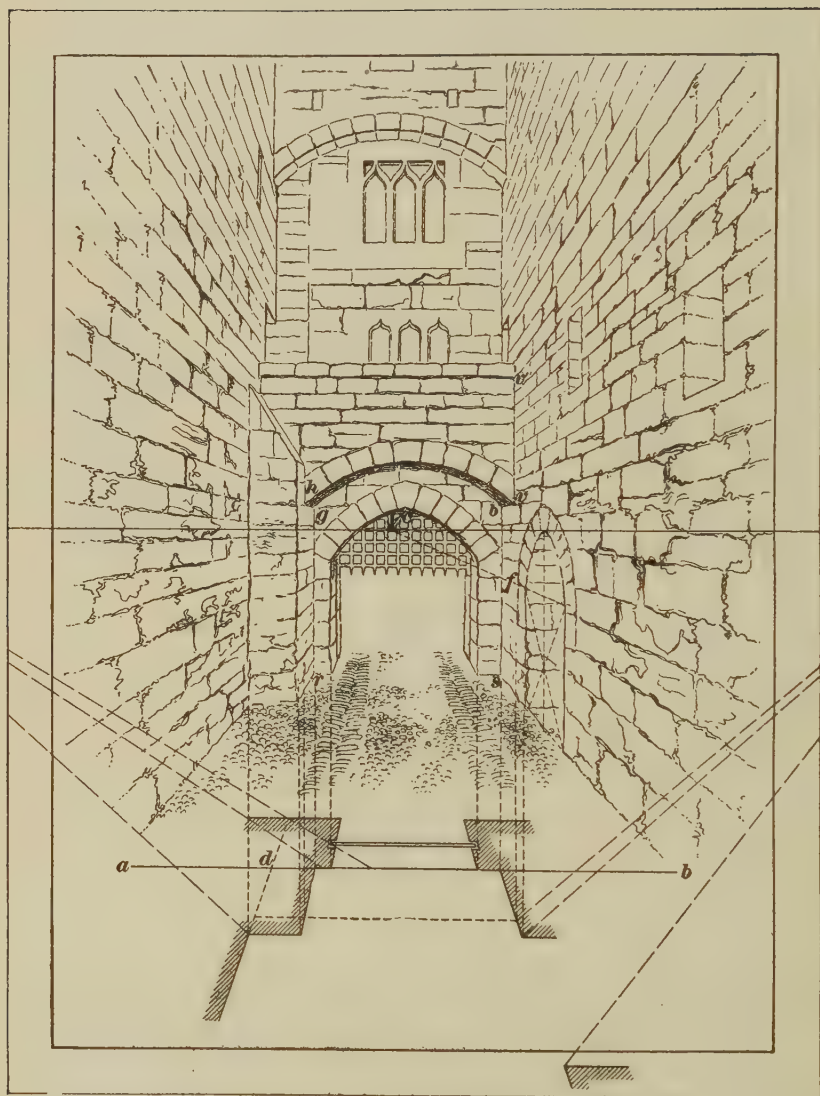


FIG. 81

PROBLEM XI

81. The problem shown in Fig. 81 is the perspective rendering of a view of the entrance gate or portcullis of Warwick Castle, England, a photograph of which is shown in Fig. 82.

82. This drawing is to be executed on the usual sheet 9 inches by 12 inches, but the vanishing points V^L and V^R will be located to the left and right of the sheet, as was illustrated in Fig. 52. The plan of the entrance and elevation of the end wall are shown in Fig. 83, and the problem is to be drawn in parallel perspective with the measuring line ab placed as shown in the plan and located in the perspective drawing about $2\frac{1}{2}$ inches above the lower edge of the sheet. The point d , Fig. 81, will be located on this line $2\frac{1}{8}$ inches from the left edge of the sheet. The horizon line should be about $6\frac{1}{4}$ inches above the lower edge of the sheet, and the vanishing points V^L and V^R 13 inches apart, the center of vision V^C being $4\frac{3}{4}$ inches to the left of the edge of the paper. All the measurements of the plan should be laid out on the measuring line ab at a scale of $\frac{1}{8}$ inch equals 1 foot, and transferred to the main lines of the plan which vanish at V^C , by means of the points V^L and V^R , as was explained previously under the heading Parallel Perspective. After the plan is complete, the various points may be projected to the perspective elevation, and the heights in the elevation can be laid out according to the measurements given in Fig. 83. The ground line rs is exactly 13 feet below the horizon and the door in the side wall is also 13 feet high to the top of the arch and 8 feet from s to f . The center of the gateway should be located according to the $\frac{1}{8}$ -inch scale, $1\frac{1}{2}$ feet to the right of the center of vision, and through this last point a vertical line should be drawn from which the centers of the arches can be located. As shown in Fig. 83, these centers are 2 feet 6 inches apart, and equally spaced each side of the center line of the opening, and are 6 feet 6 inches below the horizon line; therefore, a horizontal line should be drawn 6 feet

6 inches below V^L-V^R on which these centers are located 1 foot 3 inches each side of the center line of the opening.



FIG. 82

With the radius 8 feet 6 inches and the points so located as centers, the arcs may be drawn for the under side of the arched opening, and by lengthening the radius 2 feet the

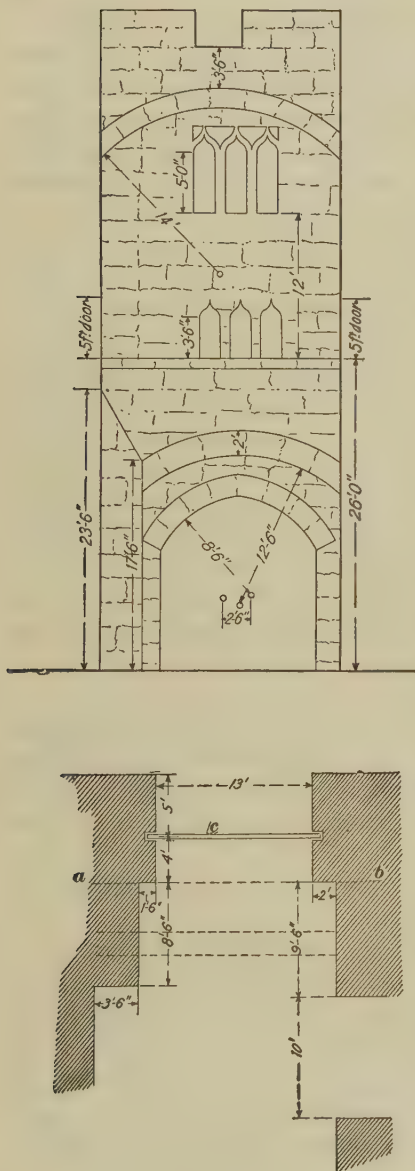


FIG. 83

outer arcs may be drawn. Now, with a point on a center line between bs and rg , and 7 feet 6 inches below the horizon, another arc should be drawn with a radius of 12 feet 6 inches showing the lower curve $g-b$ of the arch supporting the gallery wall. This arch, however, projects somewhat and it is necessary to get the location of the lines limiting this projection. So, from the corner of the right-hand pier in the plan, lay off on ab to the right a distance of 6 feet 6 inches, marking the projection of the gallery wall. Through this point draw from V^R a line to intersect the line from the corner of the pier to V^C , which will be the right-hand edge of the gallery projection, and is shown by the vertical line vv' in the elevation. A line from V^C through b will locate v , which will be the end of the curve of the supporting arch. Since this arch projects from the picture plane, its center must be projected to a vertical line

erected midway between the points v and h , by means of a line drawn through V^c . With this new center, which will be about 9 feet 6 inches below the horizon and about 2 feet to the right of V^c , another arc is struck from v to intersect with a line projected from V^c through g . The voussoirs on the arches are 2 feet deep, and the radiating lines between them are drawn toward the centers from which each arc is struck.

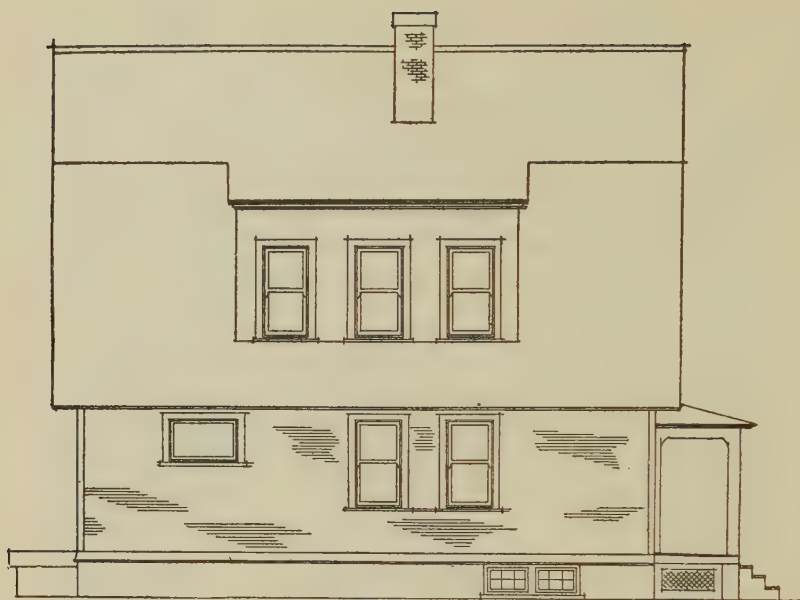
When laying out the vertical measurements of the gallery wall and buttress, it should be borne in mind that these are in advance of the picture plane and measuring line ab , and that their heights must be projected from that plane by means of lines drawn through V^c . Thus, 17 feet 6 inches and 23 feet 6 inches, the heights of the front and back edges of the buttress, are measured on a vertical line projected above r , Fig. 81, and through the points so located lines are drawn from V^c to meet the edge of the buttress in contact with the wall on a line projected above h . In the same manner, the height of the gallery wall 26 feet is measured on the vertical line sb prolonged to the lower curve of the upper arch in the elevation, and is projected to the line vv' from V^c .

The two windows in the side wall are 16 feet 6 inches and 24 feet 6 inches from the picture plane and 3 feet and 4 feet wide, respectively. Their relative positions may be ascertained with sufficient accuracy after the courses of stone are laid out. The upper portion of the structural work over the entrance is in contact with the picture plane and can be drawn directly to scale, as was the gateway.

The radius for the projecting arch over the upper set of windows, as shown in Fig. 83, is 14 feet, and the center of this arch is midway between the two walls and 20 feet 6 inches above the horizon. The amount of the projection is 1 foot 6 inches and it may be laid out on the measuring line and transferred to the perspective drawing, as was previously explained regarding the arch supporting the gallery wall.

PROBLEM XII

83. In Figs. 84 and 85 (*a*) and (*b*) are shown the plan, side elevation, and front elevation of a house. The problem is to take these plan-and-elevation drawings and make therefrom a perspective elevation. This should not prove a difficult task,



(a)



(b)

FIG. 85

Use a 20"×15" sheet of paper, and establish the vanishing points V^L and V^R at the extreme edges, thus making them 20 inches apart, and any convenient distance below the top edge of the sheet, and make V^O midway between. Use a scale of $\frac{1}{4}$ inch=1 foot. Lay out a perspective plan, say 5 or 6 inches, actual measurement, below the horizon, having corner a of the plan, Fig. 84, directly below V^O , so that the perspective plan (and eventually the perspective elevation) will be in 45° perspective. The measurements for this perspective plan can readily be transferred from the actual plan, Fig. 84, to the horizontal measuring line, and then projected to M^R and M^L to establish the horizontal measurements in perspective.

Next, the side elevation, Fig. 85 (a), should be laid off on the right-hand end of the horizon line, and the front elevation, Fig. 85 (b), on the left-hand end of the horizon line, and so placed that the bottom line of the building comes $5\frac{1}{2}$ feet, to scale, below the horizon line; that is, on the ground line. The vertical measurements for both the side and the front elevation may be obtained from the dimensioned section drawing at the left-hand margin of Fig. 85 (b).

With these data well established, the laying out of the perspective elevation will be a simple matter, if the principles already learned are applied and care is taken to observe the proper positions of all planes. For example, the vertical and the horizontal measuring lines in the perspective plan and elevation pass through point a of Fig. 84, but the planes of the eaves and gable line of the roof extend out beyond it, and the proper projections of measurements, first back to V^L and then forward from V^R , must be made to get these lines in the perspective elevation.

DRAWING EXERCISES

GENERAL DIRECTIONS

84. Tests of Student's Understanding.—The subject of perspective drawing has now been presented in such a manner that one who has studied it carefully should have no difficulty in making any kind of perspective drawing for architectural drawing work. However, the only sure test by which ability to do such work can be demonstrated is to make such drawings, and submit them to the Schools for examination, and correction if necessary.

The required work in this subject will therefore consist of five drawings, each one known as an Exercise, and drawn upon a sheet of paper 9 inches×12 inches in size. For drawing these exercises, a full-size drawing board will be required. It will be advisable to establish on this board the permanent vanishing line, in ink, with vanishing points and measuring points properly located, say, about 20 inches apart, and marked with pins, as directed on pages 66 and 67, and illustrated in Fig. 52.

All drawings are to be made in pencil, on white (or buff) cold pressed detail drawing paper.

EXERCISE 1

85. Prepare the perspective drawing of the octagonal prism, Practical Problem I, described on pages 65 to 67, and illustrated in Fig. 51, following exactly all the directions given.

Make the distances ab $2\frac{1}{2}$ inches long as directed and when ad and cb are laid off equal to one-half the diagonal of a regular $2\frac{1}{2}$ -inch square, ac and db will measure $\frac{2}{3}\frac{1}{2}$ inch and cd will measure $1\frac{1}{8}$ inches.

When completed, letter or write the title, Exercise 1: Elementary Perspective Drawing, at the top of the sheet, place

name, class letters and number, and date of completing the plate, on the back of the sheet, and send it, mailed flat in the large stiffened envelope, to the Schools for examination. While awaiting its return proceed with Exercise 2.

EXERCISE 2

86. Prepare the perspective drawing of the flight of steps, Practical Problem II, described on pages 67 and 68, and illustrated in Fig. 53, as there directed.

When completed, letter or write the title, Exercise 2: Elementary Perspective Drawing, at the top of the sheet, place name, class letters and number, and date of completing the plate, on the back of the sheet, and send it, mailed flat in the large stiffened envelope, to the Schools for examination. While awaiting its return proceed with Exercise 3.

EXERCISE 3

87. Prepare the perspective drawing of the Parthenon at Athens, Practical Problem IX, described on pages 80 to 92, and illustrated in Figs. 65 to 69, inclusive, and as there directed.

When completed, letter or write the title, Exercise 3: Elementary Perspective Drawing, at the top of the sheet, place name, class letters and number, and date of completing the plate, on the back of the sheet, and send it, mailed flat in the large stiffened envelope, to the Schools for examination. While awaiting its return proceed with Exercise 4.

EXERCISE 4

88. Prepare the perspective drawing of the house, Practical Problem VIII, described on page 80, Art. **76**, and illustrated in Figs. 61 to 64, inclusive, and in the method used for Practical Problem VII preceding it. Use a scale of $\frac{1}{8}$ inch = 1 foot and follow dimensions as given in Figs. 61 and 62.

When completed, letter or write the title, Exercise 4: Elementary Perspective Drawing, at the top of the sheet, place

name, class letters and number, and date of completing the plate, on the back of the sheet, and send it, mailed flat in the large stiffened envelope, to the Schools for examination. While awaiting its return proceed with Exercise 5.

EXERCISE 5

89. Prepare the perspective drawing of the room interior, Practical Problem X, described on pages 92 and 93, and as illustrated in Figs. 79 and 80, and as there directed.

When completed, letter or write the title, Exercise 5: Elementary Perspective Drawing, at the top of the sheet, place name, class letters and number, and date of completing the plate, on the back of the sheet, and send it, mailed flat in the large stiffened envelope, to the Schools for examination.

If any redrawn work on any of the plates of this Section has been called for and has not yet been completed, it should be satisfactorily finished at this time. When all required work on the plates of this Section has been completed, the work of the next Section should be taken up at once.

ARCHITECTURAL DRAWING

(PART 1)

INTRODUCTION

1. Architectural drawing is the special language of the architect, which he uses to convey to his client impressions of how a contemplated building will appear when completed. It is also used to convey to the contractors and workmen who perform the work of erection the information regarding size, form, materials, dimensions, etc. necessary to enable them to erect the building as the architect conceives it in his own mind.

Architectural drawing is based on the principles of projection drawing, which are applied in making the working drawings required for the erection of the building. It also employs the principles of perspective in drawings that show the building as it will actually appear when viewed from some particular point.

2. Architectural drawing does not require the extreme accuracy that is called for in some forms of mechanical drawing. A sufficient degree of accuracy is obtained by placing lines of dimensions on the drawings to define the limits of certain portions of a building.

Freehand drawing is employed to a great extent in architectural drawing. In designing a building the architect generally finds it helpful and often absolutely necessary to make numerous freehand studies or sketches illustrating various portions of the design. In making these studies a thorough knowledge of freehand drawing and facility in handling a pen

or pencil are essential. Familiarity with the principles of perspective will also be found invaluable. These freehand studies, the architect's first conception of a problem, are generally made with a soft pencil and without the use of instruments. In laying out working drawings in the customary way, instruments such as are used in mechanical and geometrical drawing are employed, and harder pencils than those used in the studies are employed.

The elements of beauty and character should always be considered in making an architectural drawing. These elements are not often considered in mechanical drawing, the aim being accuracy and economy in the use of materials. Utilitarian considerations also enter into architectural drawing, but these must be studied in conjunction with beauty and character.

3. Importance of Architectural Drawing.—As has been stated, architectural drawing is the special language of the architect. Without its use no building of any importance could be erected. The subject should be understood by all those interested in the construction of buildings, and a thorough knowledge of its meaning is a fundamental necessity in the education of an architect.

A person who is desirous of becoming an architect is urged to study this most important subject thoroughly. He should practice drawing whenever he has time to do so. He should draw carefully and studiously all the plates and exercises called for in the Sections on Architectural Drawing and send them to the Schools for correction. He should also, as a means of self-improvement, copy as many as possible of the other drawings that are shown in the figures throughout these Sections. These drawings are not to be sent to the Schools for correction.

By doing this work one may feel assured that he is improving himself in a way that will be of the greatest advantage to him when the time comes for him to do practical architectural work. The beginner should always endeavor to have his work neat and clean with clear sharp lines and careful lettering, so that his drawings will have a fine appearance. He

should, however, not forget that his object is not only to draw the lines but also the ideas conveyed by the lines. It is very desirable to make a fine looking drawing, but unless the drawing expresses useful ideas, it is of little practical value.

INSTRUMENTS AND MATERIALS USED

4. The instruments used in architectural drawing are similar to those used in all forms of mechanical drawing. Some of these instruments have been illustrated and described in the Section entitled *Geometrical Drawing*. Modifications of these instruments, also additional instruments and materials that are generally used in architects' offices, will be described here.

5. **Drawing Boards or Tables.**—In the drafting room of the average architect's office drawing boards of various sizes are used. Small boards similar to those used for the work in *Geometrical Drawing*, while useful for small drawings and sketches, are too small for general architectural use. A good average size is 3 ft. $\times$ 4 ft. The paper that is used mostly is tracing paper. It comes in rolls up to 54 inches in width, and boards must be wide enough to accommodate this, although a narrower paper can be

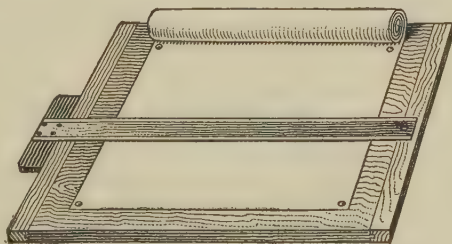


FIG. 1

used on a board 4 feet long. In drawing, particularly in detailing at full size, the roll of paper is often laid on the board as shown in Fig. 1. The draftsman starts the drawing at the bottom of the sheet and continues unrolling it as the work progresses. In this way he is enabled to make drawings many feet long. The finished portion of the drawing hangs down over the front of the board and, if necessary, it is tacked up to the front edge of the board.

Sometimes in making a full-size detail of a large figure or ornament, it is necessary, in order properly to judge proportion, etc., to lay the whole detail out in such a position that it

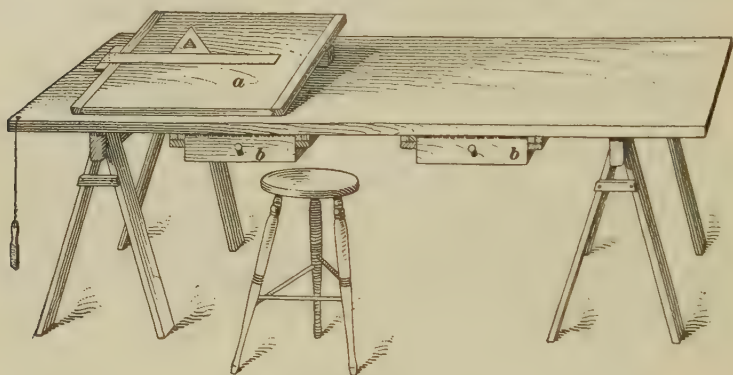


FIG. 2

may all be seen at one time, and for this purpose large boards are necessary. The average board is about 3 feet wide by 4 or 5 feet long, and the larger boards are sometimes 8 or 10 feet long.

Boards are placed on trestles, as shown in Fig. 2, and sometimes on a table, as shown in Fig. 3. Where a long board is

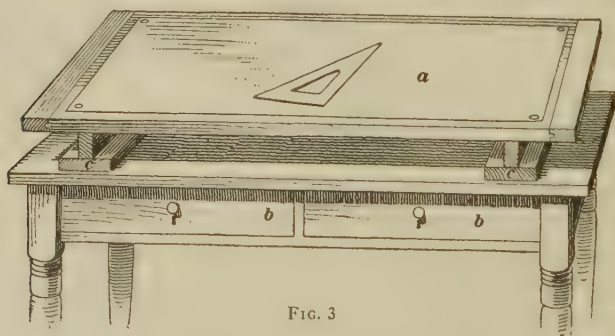


FIG. 3

laid on trestles, and it is desirable to use a smaller board, the small board may be laid on top of the long board, as shown at *a* in Fig. 2.

Small drawers, as shown at *b* in Figs. 2 and 3, are useful for keeping instruments, handbooks, etc., and where the board is placed on trestles, they may be supported on cleats that are screwed to the under side of the board, as shown in Fig. 2. At *c*, Fig. 3, are shown wooden rests for elevating the board to a convenient height. These rests may be made higher at the back than at the front, so that the board will slope.

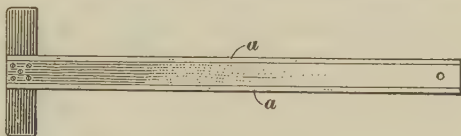


FIG. 4

6. T Squares.—Various sizes of T squares are used, depending on the size of the drawing that is made. They are usually made of straight fine-grained hardwood, with or without celluloid edges *a*, Fig. 4. The celluloid edge is very convenient, as the lines of the drawing may be seen through it. T squares are made with both fixed and swivel heads. Those having fixed heads are used mostly, although those having swivel heads, as shown in Fig. 5, are often convenient, as by

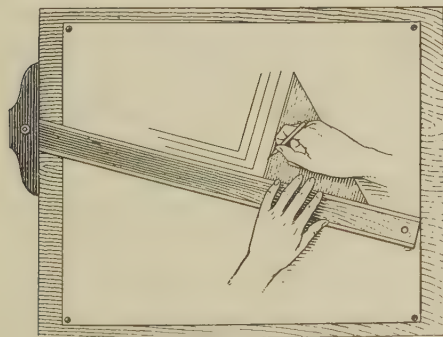


FIG. 5

the use of the swivel the blade may be set at any desired angle, and where there are a number of lines to be drawn, a saving in time is effected. The swivel head may be removed from the blade and the blade used as a straight-edge.

7. Straightedge.—Long straightedges are often useful, as, for instance, in laying out perspective drawings, and most drafting rooms contain one or more. In general form and proportion, they are similar to the blade of a T square and are sometimes 8 to 10 feet long.

8. Triangles.—Triangles are described in the Section on *Geometrical Drawing*. They are made of both wood and celluloid, the latter being preferable because of its transparency.

9. Instruments.—The instruments ordinarily used are the same as those described in *Geometrical Drawing*. In addition to those, a beam compass is often useful where large circles have to be drawn. The beam compass is composed of two parts: the point *a* and the pencil or pen *b*; these parts are attached to a straightedge *c*, and the circles drawn as shown in Fig. 6. A pen is attached to *b* when an ink drawing is to be made.

10. Scales.—The scales used are shown in Figs. 7, 8, 9, and 10. The architect uses graduations all the way from

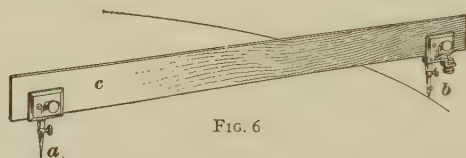
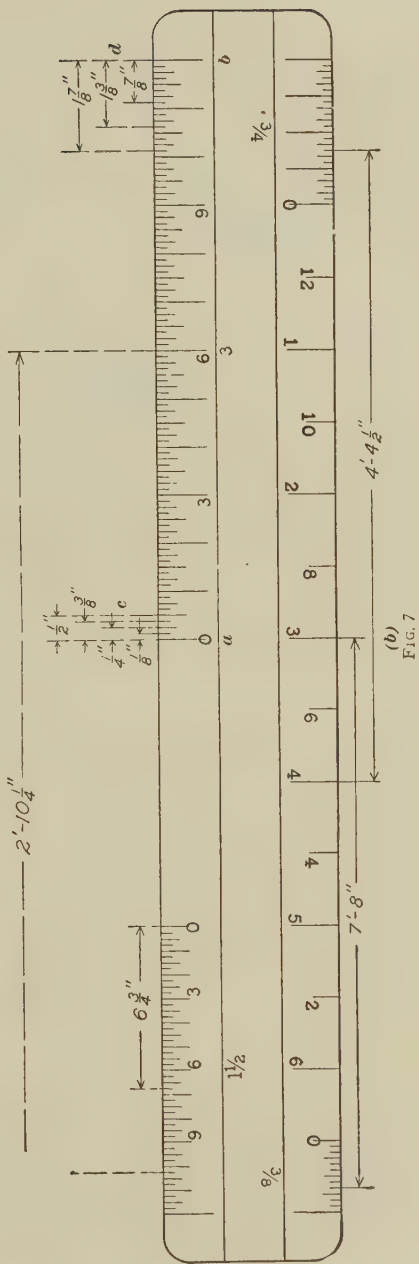
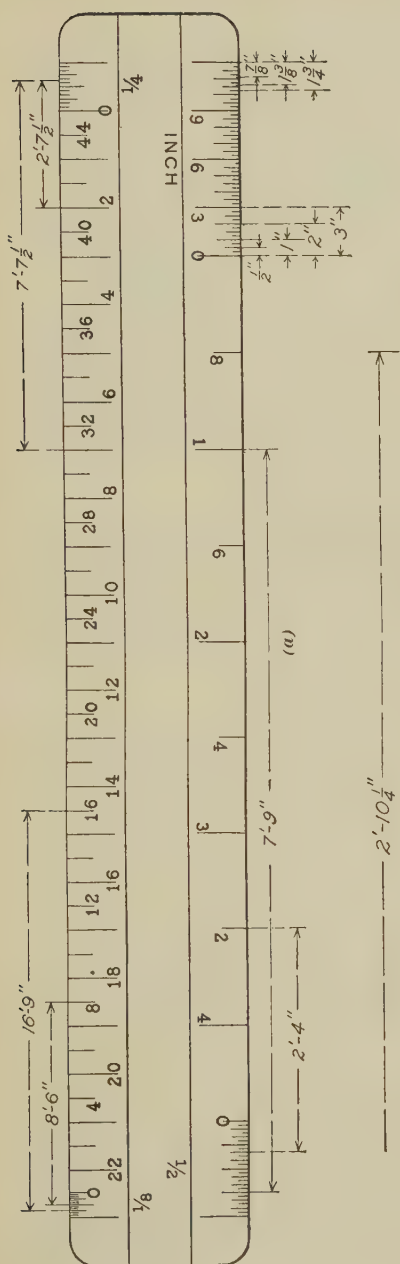


FIG. 6

$\frac{1}{8}$ inch to the foot to 3 inches to the foot. The use of the triangular scale, Fig. 8, is not recommended, as it is awkward to handle and its use is apt to cause mistakes. Flat scales, Figs. 7, 9, and 10, with white celluloid edges, are the best kind. They are made in all of the above graduations and several convenient combinations may be procured on one scale. Scales come in 6-inch lengths, which are shown in Fig. 7, also in 12-, 18-, and 24-inch lengths. The 12-inch length is mostly used. A 6-inch scale will be found very convenient at times, and can be carried in the pocket.

11. Irregular, or French, Curves.—Various sizes of irregular, or French, curves, as described in *Geometrical Drawing*, are used by the architect. Great care is essential in using them.

12. Protractor.—The protractor, although not often used by the architect, is necessary at times. It is described and illustrated in *Geometrical Drawing*.



13. Drafting Machine.—Many drafting rooms now have one or more drafting machines. The description here given refers to the Universal drafting machine made by the

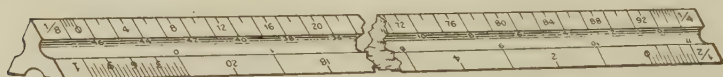


FIG. 8

Universal Drafting Machine Company, of Cleveland, Ohio. This machine has been on the market for several years. The manufacturers claim that a saving of 25 to 50 per cent. of the time otherwise required to make a drawing may be made by its use on ordinary work, and that on angular work an even greater saving may be effected.



FIG. 9

In Fig. 11 (*a*) is shown this machine attached to a drawing board. At *a* are shown the straightedges, the edges of which are marked the same as scales; at *b* is shown a knob which is held by the left hand and by which the straightedges are moved to any portion of the board; at *c* is shown a protractor used to set the straightedges at various angles; at *d* are the



FIG. 10

holders into which the blades slide. Blades or straightedges with any desired scale can be inserted in these holders at pleasure. The machine may be attached to any drawing board by means of an anchor *e*, which is screwed to the top edge of the board. This anchor may be left on the board at

all times if desired. The machine itself is readily removable from the board by unscrewing at *f*. At *g* is a spring clip.

The advantage claimed for this machine is that it takes the place of the T square, triangles, protractor, and scales. Once properly set, the machine cannot slip and is practically

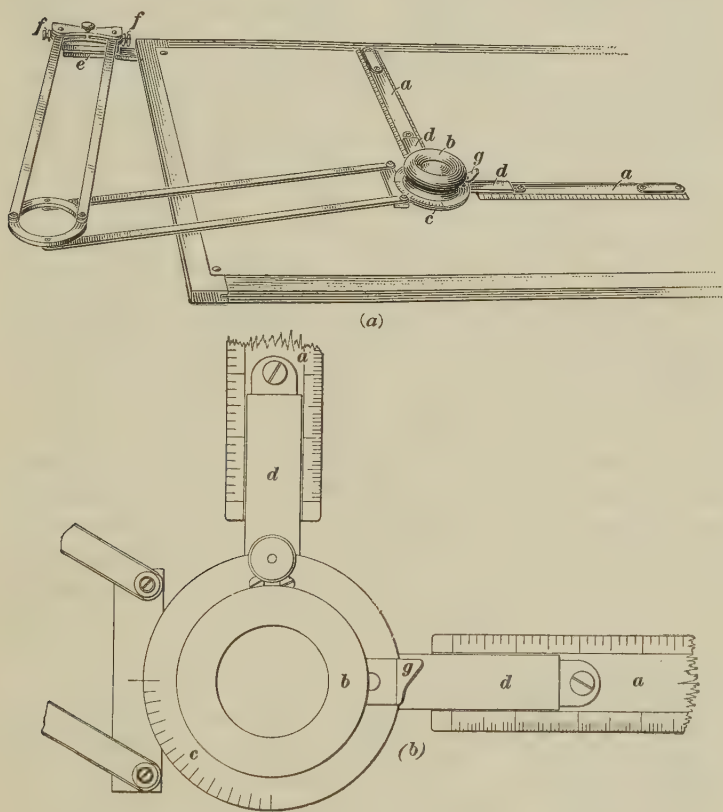


FIG. 11

accurate. By operating the clip *g*, the blades may be slid around and set at any angle on the protractor. A number of blades containing the different scales used for different purposes are furnished by the manufacturers. These machines have stood the test of several years and have given considerable satisfaction.

In Fig. 11 (b) is a large detail of the knob and adjacent parts, which are marked with the same letters as in (a).

14. Pencils.—A greater variety of pencils is used for architectural drawing than for geometrical or mechanical drawing. Grades HH, H, F, HB, B, BB, BBB, BBBB, BBBB, and 6B are all used by the architect. For general work, the F and HB are very useful. For laying out work on a small scale where absolute accuracy is essential, an H or even HH may be used, while for larger scale an F or HB would probably be used. For sketching, pencils from F to 6B are used, depending on the personal preference of the draftsman and also on his style of rendering.

Very fine effects are obtainable by a good draftsman using a soft pencil, and very accurate work may be accomplished by skilful manipulation of the same pencil. Different draftsmen have their several preferences and no hard-and-fast rule can be laid down regarding the use of pencils.

The selection of a grade of pencil is affected by the surface of the paper to be used. A coarse, rough surface will produce blacker lines and wear the point of a pencil down more rapidly than will a smoother surface. Any reliable brand of pencil may be used, and the shape should be hexagonal rather than round, as round pencils roll off the drawing board, particularly if the board is tilted. The Blaisdell is a useful pencil for sketching. It can be procured in black, white, and several colors, and is made of paper instead of wood. The black pencil is intensely black and without gloss. Colored crayon pencils are often useful and may be procured in many different shades.

The architect sharpens his pencil frequently, and uses a long, round point, the lead point being generally about $\frac{3}{8}$ inch long. Skill in the use of the pencil is of great value to the architect and it should be cultivated at every opportunity, as the ability to make good, clean lines and to obtain the various effects possible with a pencil is acquired in no other way.

For putting a fine point on a pencil, most draftsmen use a *scratch*, which is often attached to the drawing board by means

of a cord, as shown at the left-hand end of the board in Fig. 2. It consists of pieces of sandpaper glued to a small wooden handle. As a piece of sandpaper is used up, it is torn off and the clean surface of the one beneath is ready for use.

15. Pens.—The ruling pen used for making lines has been described in *Geometrical Drawing*.

For lettering and freehand work there are a number of good lettering pens obtainable. Those that are probably most generally used for freehand work are the Joseph Gillott No. 303, and for finer work, No. 170 and No. 290. The No. 303 is also good for lettering freehand, although in some localities Esterbrook's Lady Falcon is preferred. Ball-pointed pens are useful for drawing heavy lines of even thickness. Practice will tell which is best suited. A penholder with a cork grip, as shown in Fig. 12, is preferred by many draftsmen.



FIG. 12

16. Erasers.—In making architectural drawings a great deal of erasing is often necessary. For heavy papers such as *detail* paper a firm rubber is best, but for tracing paper and general cleaning up of drawings, soft rubbers are most serviceable. The sponge rubber and art gum are good, and for the final cleaning of a drawing, stale bread may also be

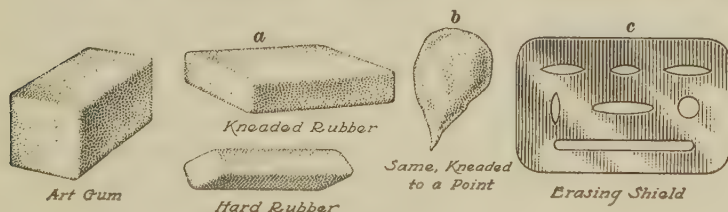


FIG. 13

used. Art gum, shown in Fig. 13, is extensively used in all drafting rooms and is probably the most popular of all soft rubbers. It may be purchased in small squares, but it is more economical to buy it in large cakes and to cut it up into the desired sizes for use. Another soft rubber is the kneaded

rubber, which comes in a small flat cake sealed in waxed paper, and is shown at *a* in Fig. 13. It may be kneaded into any desired shape for use, such as a very fine point, as shown at *b*. Although of no practical value in ordinary drafting, it is valuable for sketching and freehand work.

For erasing ink and pencil lines, a hard rubber, as shown in Fig. 13, or the usual ink eraser may be used. In making erasures, a metal shield, as shown at *c*, is used. In this shield holes of various shapes are cut so that the rubber can erase only a limited part of the drawing. Holes can be cut in cardboard or heavy paper and used in a similar manner.

17. Inks.—Black liquid waterproof India ink, as described in *Geometrical Drawing*, is the ink used most frequently by the architect. In most drafting rooms it is cus-

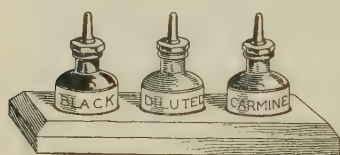


Fig. 14

tomary to use diluted black ink on certain parts of the drawing. This is made by thinning the black ink with water until the desired tone is produced. Carmine ink is sometimes used in drawing dimension lines. The usual nest of bottles used by architectural draftsmen, therefore, contains black, diluted, and carmine inks.

To avoid upsetting, the bottles are often set in blocks of wood, either singly or in a group. Fig. 14 shows a block containing the three inks invariably used. Holes are bored in the block to receive the bottles.

18. Papers.—It was formerly the practice in architects' offices to make all working drawings and details on heavy brown paper known as detail paper. This practice, however, has been discontinued in most offices and the detail paper is going out of use, except for table or drawing-board covers, where it is laid down loose and tacked or stretched. When stretched, the tack holes in the board are covered, and a smooth surface presented on which to lay other papers. Tracing paper is now used by most draftsmen for laying out their work. It is also used for detailing and sketching, preliminary

studies, and, in fact, for almost every kind of architectural drawing. Tracing paper is made of different thicknesses for different kinds of details, the heavier or thicker paper being used for the larger drawings. Samples of various papers from which a choice can be made can be obtained from the nearest dealer. Sketches may be made directly upon the paper and rendered in pencil or ink, or it may be mounted on cardboard.

In laying out working drawings the first-floor plan of a building may be drawn upon this paper and the other floor plans traced by placing sheets of the same paper over it. This method is much more rapid than the old way of laying out each floor plan on a separate sheet and then transferring the measurements from one sheet to another by means of strips of paper or scales. It also takes up much less room, as only one drawing board is required.

19. This method of placing one drawing on another is conducive to accuracy, as, for instance, in laying out a set of plans, the first floor is carefully drawn, and by placing a sheet of transparent paper over it, the exact position of the walls, partitions, stairs, and chimneys can be easily drawn upon the new sheet for the second-floor plan. This saves considerable measuring and redrawing, and prevents errors caused by inaccurate measurements. In the case of elevations, the floor heights, window heights, cornices, etc., can all be traced through from one elevation to the others with great rapidity and accuracy.

20. In detailing at small scale the details are laid out on the tracing paper also. In both working drawings and details at small scale, tracings are generally made in ink on tracing cloth by placing the cloth over the tracing paper. For full-size and large-scale detailing the details are generally drawn and completed directly on the tracing paper, from which blue-prints are made for the use of the contractors and workmen. In this case a heavier grade of tracing paper, such as will stand a certain amount of handling, is used.

Tracing paper is the most useful paper in the architectural drafting room. It comes in rolls of convenient widths, and to make its use more convenient, the draftsmen often cut the rolls into sections to suit their requirements exactly.

Bond paper, which comes in sheets 20 in. $\times$ 28 in., is useful for small drawings. It takes ink well and blueprints may be made from it. This paper is also made in rolls for large-sized detail drawings.

For fine exhibition and competition drawings and rendered drawings, white paper is used. Hot-pressed paper has a smooth surface and is suitable for pen-and-ink rendering; cold-pressed paper presents a rougher surface and is more suitable for wash drawings. Certain grades may be bought by the yard, although the finer grades come in two sizes, namely, *Imperial*, 22 in. $\times$ 30 in., and *Double Elephant*, 27 in. $\times$ 40 in. *Whatman's* is a good brand and is easily obtainable.

Gray, brown, or other shades of tinted papers are frequently employed in making sketches and studies. A pencil or pen is used for the lines and shadows, and Chinese white for the high lights, or, mixed with color, for skies and backgrounds.

21. Illustration Board.—A fine drawing paper, known as *illustration board*, mounted upon a stiff cardboard, is convenient for making fine ink or water-color drawings. It comes in convenient sizes, takes pencil, pen and ink, or wash readily, and saves the time that would be spent in stretching ordinary paper to prepare it to take water colors.

22. Stretching Papers.—To take a wash properly, paper should be *stretched*. To do this, the sheet of paper to be stretched should be laid on a board, and the edges turned up 1 inch to $1\frac{1}{4}$ inches all around. The whole surface of the paper inside of the turned-up edges should be wetted by means of a sponge or soft cloth, and strong paste or glue spread on the outside of the turned-up edges. The surplus water should then be removed from the paper, and the edges pressed down on the board, beginning at one corner. During this process of pressing down the edges, the paper is stretched by pulling

the edges toward the edges of the drawing board. This is done best by two persons pulling the paper in opposite directions at the same time. When the edges are all pasted down, the board is set up to dry, and after it has dried, the paper will be found to be perfectly smooth and tight. Whatman's drawing paper may be stretched in this fashion. Care should be exercised, however, in stretching, for if the paper dries too tightly it is liable to split.

In stretching tracing paper, a slightly different method is used on account of the weakness of the paper. This paper must be stretched on a piece of heavy paper which has already been stretched on a drawing board. The edges of a piece of tracing paper are gummed and pasted on stretched paper. This is done while the tracing paper is dry. When the edges have set, the surface inside the edge is moistened with a wet sponge. This moisture will soon evaporate and the paper will stretch tightly over the surface beneath with comparative safety. Too much water should not be used or the paper may pull apart.

23. Mounting Papers.—Thin papers, such as tracing papers, are often mounted on heavy cardboard so as to present an absolutely firm and even surface. This is often done after a drawing has been made on the paper. The paper to be mounted is laid face down on a clean, cheap paper, such as a sheet of newspaper, and thoroughly moistened. Paste, such as a good library paste, should be diluted and applied uniformly over the entire surface. The cardboard upon which the paper is to be mounted should also be moistened slightly. The paper should then be carefully lifted by two persons and placed, with the paste side down, against the board. A clean, dry sheet of cheap paper should be placed on the face of the mounted paper, which is pressed down and all wrinkles pressed out, by moving the hands from the middle of the paper to the outer edges. In mounting tracing paper, a small triangle can be used to work out the wrinkles and any superfluous paste or glue. White paste should always be used when mounting tracing paper, and it should be very dilute.

24. Tracing Cloth.—Where a drawing is to be handled very much by referring to it frequently or in making many prints from it, tracings of it are made on *tracing cloth*, which is a linen treated so as to make it transparent. This cloth is sold in several different grades, but the finest quality is, as a rule, the cheapest.

A draftsman makes a working drawing to a small scale on tracing paper and then places a sheet of tracing cloth over this drawing and by means of ink traces the lines through on the cloth. This results in a strong, serviceable drawing from which any required number of blueprints may be made.

Draftsmen sometimes lay out the working drawing in pencil directly on tracing cloth, and ink it in when complete. The dirt and unnecessary pencil marks may then be erased from the finished ink drawing by wiping the entire surface with a piece of cheese cloth moistened with gasoline or benzine. In using gasoline or benzine the tracing should be rubbed lightly, as hard rubbing will tend to remove the ink lines.

The two sides of tracing cloth are not alike, one being very smooth and shiny, and the other rough. The rough side takes pencil better than does the smooth side and is also the side used by most draftsmen for ink tracing, although some draftsmen prefer the smooth side.

Imperial tracing cloth is a good and well-known brand. There are several other brands that will do just as well and there are a number of brands that are more moderate in price.

Because of its somewhat oily or greasy surface, the ink will not flow well on tracing cloth unless the surface is first cleaned. This is generally done by rubbing powdered chalk over the surface and wiping the loose chalk off with a soft cloth. Talcum powder is sometimes used, or where no chalk or powder is available, a blotter rubbed over the surface will remove most of the objectionable grease, which may also be removed by wiping the surface of the cloth with gasoline or benzine.

25. Tracing Cloth for Pencil.—Because of the vast amount of work turned out by some of the larger architectural offices and the demand for speed in producing working drawings,

many architects have objected to the time required to trace drawings in ink and insisted upon completing even their working drawings in pencil. Because tracing paper would not bear much handling, it was not suitable for finished working drawings, and the regular tracing cloth did not take pencil and erasing well enough to be satisfactory for the purpose. To meet this demand for a material that would take pencil well and at the same time stand more or less rough usage, the manufacturers have put on the market a tracing cloth that is very transparent. This paper takes pencil well, can stand repeated erasures, and possesses all the well-known qualities of durability that are popularly associated with tracing cloth, as compared with a paper.



FIG. 15

26. Thumbtacks.—In securing paper to the drawing board, thumbtacks are used, as described in *Geometrical Drawing*. In architects' offices a small-sized tack is generally serviceable, such as the *Bayonet*, which is stamped out of sheet steel, as shown at *a*, in Fig. 15. At *b* is shown a tack with a solid head and a point inserted in it.

ARCHITECTURAL DRAWINGS

CLASSES OF ARCHITECTURAL DRAWINGS

27. It is customary, in order to produce a complete building, to make several classes of drawings. These are preliminary studies, preliminary sketches, working drawings, scale details, and full-size details.

28. Preliminary Studies.—The architect, whether he has been engaged to take charge of the erection of a building, or whether he is entering a competition with the hope of receiving the order to build, obtains all the data regarding conditions under which the building is to be erected and a list of the rooms and accommodations required, and proceeds to make the preliminary studies.

Preliminary studies are simple freehand sketches which the architect or draftsman makes while formulating his ideas for a building. The studies are made in soft pencil or with pen and ink on pieces of paper of any kind, and indicate rough groupings of the various parts of the proposed building. A convenient paper upon which to make such sketches is a *quadrille ruled paper*. By this is meant a paper that is ruled in small squares. Each square can be assumed to be 2, 5, or 10 feet in length, and rooms, passages, etc., can be sketched approximately to any desired size without the aid of a scale. An architect makes several such studies until he thinks he has the best possible arrangement of the various features of the plan.

An example of a preliminary study on quadrille ruled paper is shown in Fig. 16. Each square represents a space of 5 ft. $\times$ 5 ft., and the rooms are roughly laid out of the desired size. In (a) is given a sketch of the first floor; in (b) a study of the second floor; in (c) a study of the front elevation, and in (d) one of the side elevations. These sketches express the idea of the house very clearly and suggest points that may be improved on in further studies. From such sketches a draftsman would be able to lay out a drawing to the $\frac{1}{16}$ -inch or $\frac{1}{8}$ -inch scale. With a little practice, studies like these can be made in a very few minutes, and different ideas tried out in a short time.

The draftsman then tacks down a piece of paper and draws out roughly the chosen scheme to a scale of $\frac{1}{16}$ inch or $\frac{1}{8}$ inch to the foot, and redraws the elevations or fronts of the building until the entire solution of the problem seems satisfactory. Facility in drawing, especially in freehand drawing, is of great value in making preliminary studies. A knowledge of shades and shadows, perspective, and coloring with water colors or colored crayons, is also of great assistance in working out these studies.

29. Preliminary Sketches.—When a satisfactory design or scheme for the proposed building or buildings has been arrived at through the medium of preliminary studies,

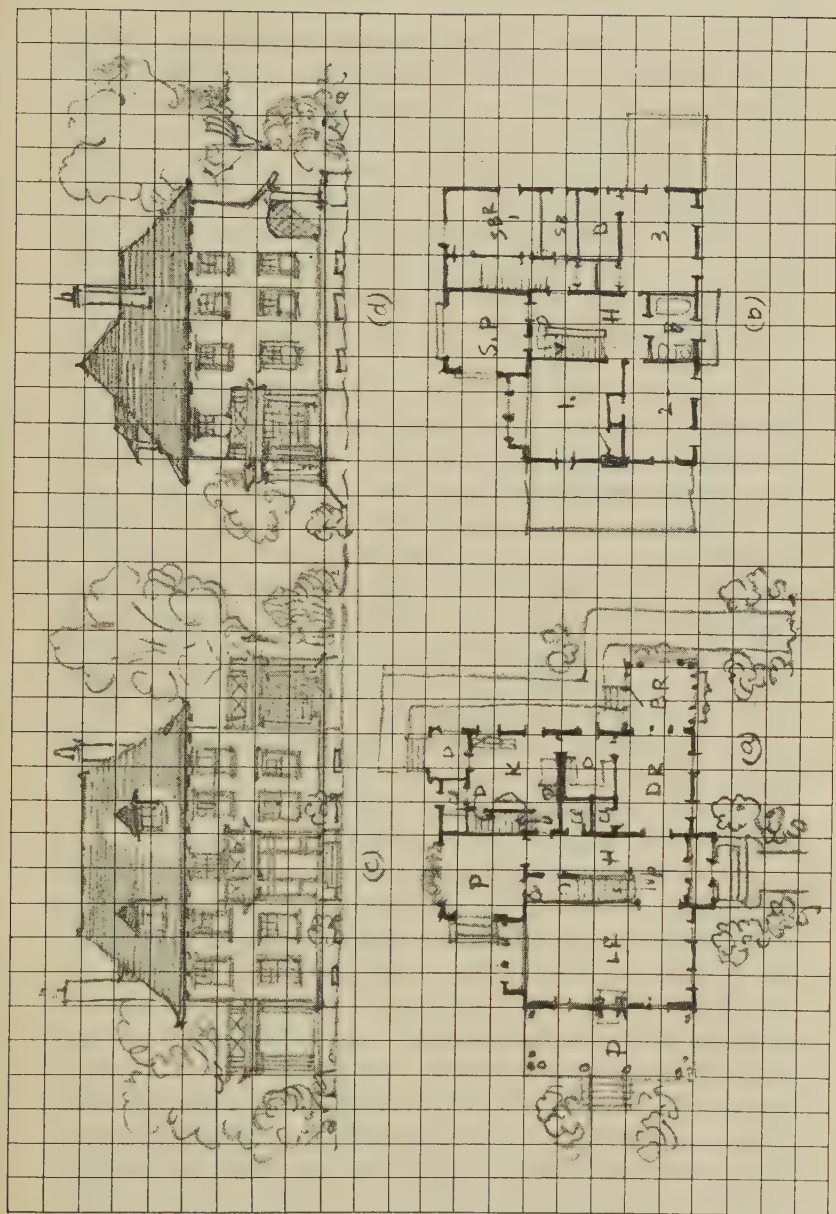


FIG. 16

the draftsman proceeds to make preliminary sketches to show to the client, or owner of the proposed building. These sketches are generally drawn to a scale of $\frac{1}{16}$ inch or $\frac{1}{8}$ inch to the foot. Only the principal dimensions are given and the drawings, particularly the elevations, are generally *rendered*, that is, they are shown with landscape and other surroundings, as they would actually appear if built. Various mediums are used in the rendering of these sketches, such as pencil, pen and ink, pastels, water colors, and sometimes oil paints. Each designer generally has his own particular preference, the object being to present to the client sketches that will show him how his building will appear when completed. These sketches should contain sufficient data and should be drawn accurately enough to enable any competent draftsman to make working drawings from them.

Examples of preliminary sketches are shown in the succeeding Section. When such sketches are ready for presentation they are shown to the client, who generally requires that some changes be made. This usually necessitates the making of additional sketches. When the changes have been made and the client is satisfied, the architect turns these sketches over to his draftsman, who proceeds to lay out the working drawings. Preliminary sketches, though they convey a good general impression as to how the building will appear, give none of the detailed information relative to the exact sizes of the different parts, the materials to be used, etc. It is necessary to give this information to enable the contractors to figure the cost and also to enable the workmen to construct the building. It is, therefore, necessary at this stage of the proceedings to make a complete set of working drawings.

30. Working Drawings.—The working drawings must be as complete and accurate as possible. They consist of sheets showing plans of the different floors, the basement, and the attic; elevations of the front, rear, and sides of the building; sectional elevations, or sections, through the principal portions of the structure. The sections show details of particular parts that cannot be shown properly on the plans or

elevations. All necessary dimensions should be noted on these drawings. The working drawings are generally drawn to a larger scale than the sketches. The plans, elevations, and sections are generally drawn to the scale of $\frac{1}{4}$ inch to the foot. On very large work they are sometimes drawn to the scale of $\frac{1}{8}$ inch to the foot, so that the drawings may be made on sheets of paper or cloth of a convenient size.

Working drawings are never rendered or colored, but are plain line drawings. They are generally finished in ink on tracing linen or cloth, or in pencil on cloth or paper, and then blueprinted.

The materials of which the building is to be constructed are indicated on these drawings by various markings made with the pencil or pen. These indications will show in the blueprints. Colored washes and lines will not reproduce in color on blueprints and are little used on that account.

The working drawings, together with the specifications, form the basis of the contract to construct the building. They are documents forming part of that contract and are, therefore, sometimes referred to as *contract drawings*.

The working drawings are first laid out accurately and drawn with pencil on tracing paper with dimensions carefully figured and checked. They are then generally traced on tracing cloth, by laying the cloth over the paper and tacking it down on the board. This tracing is generally done with India ink, dimensions and notes are put in, the title is lettered, and the sheet is ready for blueprinting. The set of blueprints accompanying this Section shows a completed set of working drawings from which the building can be erected.

31. Scale Details.—After the working drawings have been completed and the specifications which describe the work to be done on the building have been written, the architect proceeds to make scale details, which are drawings of certain parts of the building at a larger scale than that used for the working drawings. This is done with parts of the building, such as the windows, doors, cornices, porch finishes, etc., which cannot be shown clearly at a scale of $\frac{1}{4}$ inch. The

scales commonly used in making these drawings are $\frac{1}{2}$, $\frac{3}{4}$, 1, $1\frac{1}{2}$, and 3 inches. Examples of scale details are shown later on.

32. Full-Size Details.—It is necessary to show some portions of the building at full size. Carvings, moldings, and similar details of a building cannot be satisfactorily shown in any other way. Full-size details often make very large drawings, but can generally be shown on large sheets of heavy tracing or bond paper from which prints can be made.

33. Plans, Elevations, and Sections.—The **plan** of any object is the projection of it as seen from above. In the case of buildings, there may be several plans. The plans in this case are horizontal sections taken through the building, one at each story. There is usually a plan for each story, and the plan shows the building as it might appear with the upper parts removed. The arrangement of walls, partitions, doors, windows, chimneys, stairs, etc., should all be shown in their proper relative positions.

The **elevations** are projections or views of the exterior of a building, and give the relative heights of its various parts. The height of the stories, windows, doors, porches, roofs, and chimneys are shown on the elevations. The term elevation is also applied to the projection of any part of the building viewed horizontally.

Sections, or sectional elevations, are sections through the building made by vertical planes. These drawings show the elevations of the interiors of the various rooms, of the stairs, chimneys, together with cuts or sections through the floors, walls, and roof. A section is a very useful drawing, as it gives information which cannot be shown in an elevation or a plan. The accompanying blueprints show examples of plans, elevations, and sections.

The principles of projection drawing are employed in making these drawings, one from the other, and a good knowledge of these principles will be of the greatest value. Plans, elevations, and sections are necessary to show not only the entire building, but are made when showing the details of the

building, such as windows, doors, chimneys, stairs, etc. In fact, practically all parts of a building can be completely shown by the use of these three kinds of drawings. Examples of the application of this fact will be found in various drawings shown later on.

NECESSITY FOR KNOWLEDGE OF CONSTRUCTION AND MATERIALS

34. Familiarity With Construction.—The architectural draftsman should possess a good knowledge of construction and the application of the numerous materials employed in the erection of buildings, gained as the result of actual work on buildings, or by observation of building operations. A great deal can be learned, however, from the study of books treating of the various materials and methods of construction. Considerable information will also be gained by studying the successive plates carefully, while drawing them, until they are thoroughly understood. It should always be remembered that most drawings are made to show how the various building materials are put together harmoniously in order to produce specific results.

The value of reading the most up-to-date books published on all phases of the architect's profession, and the benefits of being a regular reader of one or more architectural magazines, are inestimable. However, the most fruitful method of obtaining valuable practical information on house planning and house building is to watch a house or other building in actual process of construction. There are very few towns or villages, however small, where numerous opportunities to observe buildings being erected do not exist. The aspiring architect need not go out of his way to find them; all he needs to do is to keep his eyes open and observe, and endeavor to understand what he sees.

35. Materials Used in Building.—A number of materials, such as stone, iron, and steel, brick, terra cotta or tile, plain and reinforced concrete, and wood, enter into building construction, and of all these and their uses the architect

must have a good working knowledge. Iron, steel, terra cotta, and reinforced concrete enter largely into the construction of large or fireproof buildings. These materials are used only to a limited extent in moderate-size dwellings, which are generally constructed entirely of stone, brick, concrete, and wood. Wood, however, is the predominating material.

36. Wooden Buildings.—Wooden buildings are of two classes of construction. One kind is carefully framed together with all the joints fitted like the details of a piece of furniture, and is called **braced-frame construction**. In this class are structures such as large mills, warehouses, coal pockets, and other buildings that require great strength. The framework of the building itself is made to withstand all strain regardless of covering or finishing material. The other class, called **balloon-frame construction**, has its frame work simply nailed together, with seldom any fitting of joints. The framework in this case is a rather flimsy affair, but when it is covered with sheathing boards laid diagonally, each board acts as a brace and helps to secure the frame to which it is nailed. When entirely complete such a building is homogeneous and stiff and capable of resisting all the strain that it is likely to receive. This system of framing is used for residences, stores, and other buildings where great strength is not required. There are various modifications of the balloon type of framing that are used in different parts of the country, such as the *Western-frame construction*. There are also combinations of all these different methods.

37. Example.—The method of making the lines of a drawing for a building and the actual construction that the lines represent, is shown in Fig. 17. In (a) is a plan of one wing of a dwelling drawn in the usual way, so far as the outer walls are concerned. As this is drawn simply for the purpose of illustrating the arrangement of these walls, the interior arrangement is not shown. In (b) is shown the elevation of one side and in (c) the end elevation. Both the plan and the elevations are drawn in the way in which working drawings

are usually prepared. In (d) is a perspective view of the corner of the structure as it would look if actually completed.

38. In Fig. 18 is shown the framing of the same structure from the same position but with all the finishing work left

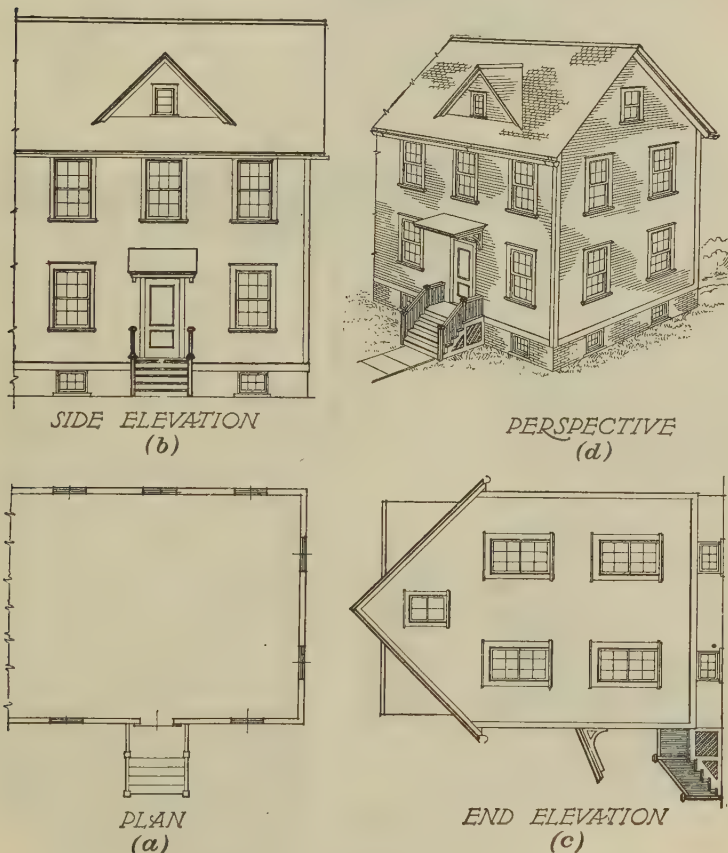


FIG. 17

off, and in the balloon-frame type of construction. The sill *a* is set back of the brick foundation wall about 1 inch, so that the sheathing *g* will be flush with the brickwork. The corner posts *b* are simply spiked or nailed in place. Wherever possible the studs *c* are in one piece, extending from the sill

to the roof plate *d*, but if the proper length cannot be obtained, they are spliced. The studs are simply nailed into position,

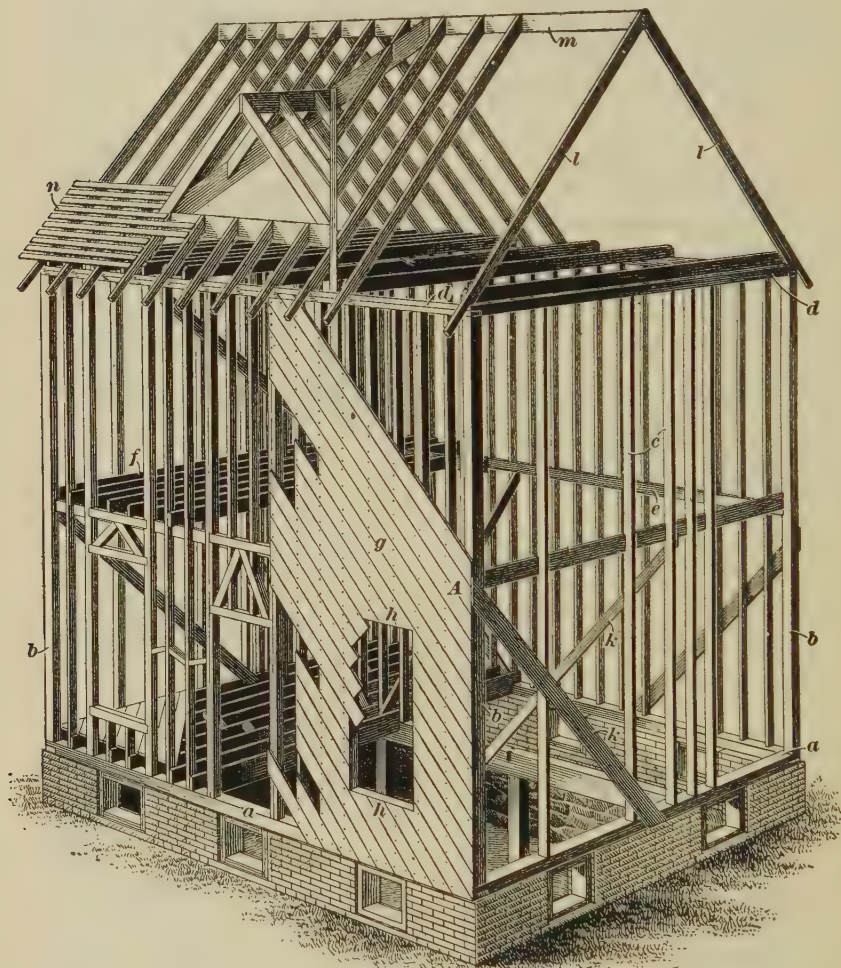


FIG. 18

and the ledger boards, or ribbons, *e*, which are $\frac{7}{8}$ inch in thickness, support the second-story beams *f*, and are let into the faces of the studs and nailed to these studs. The sheathing *g*

is securely nailed to each side of the structure in a diagonal position, and serves to brace it thoroughly. In putting on the sheathing, no attempt is made to fit it to the window openings, but these openings are sawed out, as shown at *h*, after the sheathing is placed. Temporary braces, as shown at *k*, are usually employed to hold up the structure until the sheathing is placed and the building made secure. The lower ends of the roof joists, or rafters, *l* rest on the plate *d*, while at the head they rest on the ridge board *m*. The attic-floor beams over the second story are nailed to the rafters wherever practical. In this way they tie the two ends of the rafters together and overcome any tendency they may have to spread out and slide off. In buildings where the ceiling beams are so placed as not to give convenient nailing space for the rafters, a tie is generally carried across the building and nailed to each pair of rafters so as to prevent them from separating. Shingle laths consisting of small strips of wood, as shown at *n*, are sometimes laid over the rafters at intervals equal to the exposure of the shingles. In some cases roofs are covered with wide boards laid close together. This is not as good for a shingle roof as using shingle laths, as it prevents the proper ventilation of the under side of the shingles with which the roof is finally covered. In cold climates, however, it is found necessary to board the roof over so as to conserve warmth, even when shingles are used.

39. Building Material Sizes, Etc.—The sizes of building materials, such as lumber, glass, brick, etc., have been described previously; a good knowledge of these materials and the methods in which they are used is indispensable to the architect in making the drawings.

FAMILIARITY WITH ARCHITECTURAL DESIGN NECESSARY

40. While an acquaintance with the materials used in buildings and the processes necessary to put them together is indispensable to the architectural draftsman, a knowledge of the principles of architectural design is of even more impor-

tance. It is necessary to know where to put the stone, brick, wood, etc., and this is determined by various considerations, such as beauty, appropriateness, proportion, scale, and other matters.

41. Architectural Design.—A detailed discussion of the subject of architectural design is not proposed at this time. This subject will be taken up later. The following brief discussion is intended to give some idea of the different considerations that enter into the planning and affect the design of a given structure.

If an architect is called upon to design a dwelling to be occupied by the owner and his family, it is essential that he should know what considerations will enter into the solution of the problem and what are the deciding factors or requirements.

42. Essential Requirements.—In the planning of any dwelling the most important considerations are the comfort and convenience of the occupants. The matter of cost is also important in most operations, as it would obviously be a waste of time for the architect to design a dwelling that, although it might be ideal in every other respect, could not be constructed for the amount of money that the client had to spend.

43. Comfort and Convenience.—A man's dwelling should fit the requirements of himself and of every member of his household. To accomplish this end, the architect must, as one of the first considerations, find out his client's mode of life with regard to his domestic habits and necessities. He must also be informed in these matters with regard to the other members of the household, the information extending also to the servants, if there are any. In possession of this information, the architect must proceed to design, so far as he can with the amount of money that the client has to spend, a dwelling that will meet every requirement of comfort and convenience. It must also be satisfying and pleasant to look upon, thereby combining to the maximum degree the elements of utility and beauty.

44. Proper Arrangement of Parts.—Having determined from a discussion of the requirements of the client and his family the approximate number, kind, and size of the rooms required, the next important step is the consideration of the proper arrangement of the different parts with relation to each other. This ordinarily requires a great deal of careful study, arranging and rearranging, tracing and retracing, before a satisfactory arrangement is finally worked out. The architect generally makes his first studies freehand as described, then he proceeds to the preliminary sketches and lays them out to scale. He then studies the different arrangements of rooms by the simple process of laying pieces of tracing paper over completed layouts and trying different arrangements of different portions until a satisfactory one is secured. In studying the interior arrangement of rooms, the effect on the exterior appearance must also be considered, and, before getting too far in the interior arrangement, the designer must commence his sketches of the exterior so that the study of the exterior may be carried right along at the same time with that of the interior, since the placing of window and door openings, dormers, bay windows, etc., affects not only the convenience of the interior arrangement, but the exterior appearance as well.

45. Economy.—The consideration of economy is of primary importance. It would obviously be a waste of time, for instance, for an architect to design a dwelling for a client that would meet perfectly his requirements as to comfort and convenience, but that would cost \$12,000 to build, if the client had only \$8,000 to spend. It is, therefore, essential that the architect consider from the very beginning the matter of economy in connection with the design. He should ascertain as nearly as possible just how much money his client will spend for his dwelling and he should keep this in mind in making his design. He should make approximate estimates of the cost of his studies or designs. In order to accomplish this, it is necessary that he should familiarize himself with the cost of the different materials and classes of labor enter-

ing into the construction. In addition, he may call upon one or two responsible contracting builders for their approximate estimates of the cost. It is one thing to solve successfully for a client the problem of comfort and convenience in a dwelling without regard to the cost, but it is quite another thing to solve the problem while keeping within a certain stipulated amount, and the architect must not lose sight of this fact. The cases where an architect is permitted to go ahead without regard to expense are about as rare as it is possible for anything to be.

46. Choice of Materials.—The matter of choosing materials to be used in the structure may be affected by any or all of a number of considerations. Some of these are cost, proximity to the site, availability at the particular time at which they will be needed, sentiment, etc. Here, again, it will be necessary that the architect have a knowledge of the prices of the different materials to guide him in making his decision. The style in which he is designing, the color scheme, etc. will also affect the decision.

47. Site, Grade, Etc.—The design of a building may be greatly influenced by the site and the grade, or contour, of the ground at the site of the proposed building. In the problem of designing a dwelling on an ordinary city lot, the architect should obtain from the client the exact size and location of the lot. He should also have the grade or contour of the ground. This will not be needed for the preliminary studies unless the contour is so uneven or diversified as to affect materially the design of the intended structure. If the architect did not have the grade in the preliminary stage of the work, before proceeding from the sketches to the actual working drawings he should either send an engineer or go himself to take the grade of the lot, as it will be necessary to establish on the working drawings the height of the first floor above the ground, the depth of cellar, etc. Elevations should be taken at the sidewalk in front of the dwelling, and at the four corners of the dwelling at least; and also at as many more points as required by any irregularities of the ground.

The architect should also obtain from the city engineer or other officials having the matter in charge, the location of the sewer and water mains in the street and their depth below the surface of the ground at the points where the house lines will enter these mains. This will enable him to allow for the proper fall in the sewer from the house to the mains.

48. Simplicity in Form.—Simplicity in form, both with regard to the arrangement of the floor plans and the exterior design, should be the goal of the architect. Simple plans are invariably the most workable, the most convenient, and the best. Complicated arrangements should be avoided; a convenient arrangement of rooms with a minimum of corners, angles, turns, and twists, can generally be obtained by sufficient study of the problem, and, in addition to giving a better opportunity for treatment of the exterior, the simple plan constitutes much more economical construction than the one having a multiplicity of corners and angles.

49. Beauty.—Every man doubtless desires his dwelling to possess at least some of the elements of beauty, although very few persons could give an intelligent definition of the term beauty, and no two definitions would be the same. In solving any architectural problem, the elements of both utility and beauty must be considered and so coordinated and combined as to present a harmonious whole. The dwelling under consideration should, when completed, meet every requirement of comfort and convenience of the occupants and present a well-proportioned exterior, and a pleasing example of the particular style of architecture in which it is designed.

IMPORTANT DETAILS OF PRACTICAL WORK

50. An architectural drawing is the means used by the architect to express ideas, and each line and mark placed on a drawing has a definite meaning. Placing unnecessary lines and marks, and repeating an idea a great number of times on working drawings, should be avoided. These ideas should always be expressed as clearly as possible in order to avoid

misunderstanding of the drawing. When the idea cannot be expressed fully and accurately by lines alone, lettering should be used to make the idea complete. This lettering should be done very carefully and neatly, so as not to spoil the appearance of the drawing.

51. Some architects and draftsmen make copious notes on their drawings describing the kinds of materials used, the finishes of these materials, and other matters that properly belong in the specifications. This practice is undesirable, as it is apt to give the drawings a confused and crowded effect. Points that are covered in the specifications should not, as a rule, be repeated on the drawings.

52. Lettering Drawings.—The lettering required for the average drawing includes the title of the drawing which explains what it shows, as, for instance, FIRST-FLOOR PLAN. The scale to which the drawing is made, the name of the client, the location of the building, and other data, should also be given. In large offices a rubber stamp is sometimes used to give some of this information, and has spaces that must be filled with lettering. Examples of properly lettered drawings will be shown later.

53. Keeping Drawings Clean.—It will take some time to complete a drawing, and in all probability it will become soiled on account of the lead from the pencil and fine particles of dust in the air being rubbed back and forth over it by the motion of the T square and triangles. It is advisable to cover part of the paper or cloth with tracing paper, which can be tacked down to cover the parts not in immediate use. These parts will thus be kept clean while work is being done upon the exposed part. When one part of the drawing has been finished it can be covered with tracing paper and another portion of the paper exposed. This method tends to keep the paper cleaner than if the whole paper were exposed at one time.

54. Use of Tracing Cloth.—Tracing cloth is affected by moisture, and when freshly unrolled and exposed to a

damp atmosphere will swell and buckle. If a tracing is being made on cloth and is allowed to remain uncovered overnight and the weather is damp, the cloth will stretch and the part of the drawing traced will no longer fit over the drawing beneath and sometimes the drawing is ruined. Great care must, therefore, be taken to keep tracing cloth as dry as possible, especially during the time in which a tracing is being made. This is done by covering the tracing at night with a cloth or by turning the board upside down so that the tracing rests on the surface of a drawing table. Sheets of paper may also be tacked over the tracing cloth when not working on it. Some draftsmen cut suitable sized pieces of tracing cloth from the roll a day or two before they expect to use it and expose it to the air in the office. This exposure will cause the cloth to expand and contract, so that it will not shrink or swell while the drawing is being made on it. In cutting a piece of cloth off the roll, the selvage should always be removed or else the cloth will pucker or gather along the edge. The selvage is at the edges or sides of the cloth, and shows at the ends of the roll.

Water coming in contact with tracing cloth will ruin it by taking away its transparency.

Often when the cloth is rubbed with powdered chalk it will stretch a trifle. In such a case it is advisable to take out the tacks which hold the cloth in place and tack it down again, pulling it tightly while it is being tacked.

These points are valuable to remember while using tracing cloth in drawing the plates and when drawing in an architect's office.

55. Use of Scales.—It is obvious that a large object such as a building cannot be conveniently drawn at its actual size. Buildings are therefore *drawn to scale*, that is, they are drawn at some convenient fraction of their size. Thus, the floor plans of a building are generally drawn to the scale of $\frac{1}{4}$ inch to the foot, or $\frac{1}{4}$ of an inch represents 1 foot of the actual size. In this case the drawing represents one forty-eighth of the actual size. Certain standard scales are used in making

architectural drawings. These and also the fractional part of the actual size each represents are shown in Table I.

The scale of $\frac{1}{8}$ inch to the foot is used for drawing the plans and elevations of a large-sized building, and the $\frac{1}{4}$ -inch scale for a building of moderate size. The scales of $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$ inch to the foot are used in showing details of portions of the entire building, such as the interior of a room, the details of a chimney, or the details of a porch. When it is desirable to show the construction or detail of a part of a structure with

TABLE I
STANDARD SCALE USED AND FRACTIONAL PART OF
ACTUAL SIZES

Standard Scale	Part of Actual Size	Standard Scale	Part of Actual Size
$\frac{1}{8}$ in. to 1 ft.	$\frac{1}{96}$	$\frac{3}{4}$ in. to 1 ft.	$\frac{1}{16}$
$\frac{1}{4}$ in. to 1 ft.	$\frac{1}{48}$	1 in. to 1 ft.	$\frac{1}{12}$
$\frac{3}{8}$ in. to 1 ft.	$\frac{1}{32}$	$1\frac{1}{2}$ in. to 1 ft.	$\frac{1}{8}$
$\frac{1}{2}$ in. to 1 ft.	$\frac{1}{24}$	3 in. to 1 ft.	$\frac{1}{4}$

special clearness and still not draw it at full size, the larger scales, such as 1 inch, $1\frac{1}{2}$, and 3 inches to the foot, are used. A person will learn by experience which of these scales is most appropriate for different kinds of work.

56. Description of Scale.—The instrument used in measuring off these various scales on a drawing is itself called a *scale*. Thus, a draftsman uses a scale to lay off dimensions on a drawing and to obtain dimensions from a drawing. This instrument is, next to the pencil, the most important instrument that a draftsman uses and its use should be practiced freely. There are different styles of scales made to suit different tastes. In Fig. 8 is shown a triangular scale, which is usually made of boxwood, but sometimes of metal, and the various scales or systems of marking mentioned in the preceding article are engraved on the edges. There are on the triangular scale six edges. As a rule, two scales are marked

on each edge, and twelve scales can be accommodated on the six edges.

Another type of scale that is more convenient to use than the triangular scale is the flat beveled-edge scale, which consists of a flat strip of boxwood with both edges beveled, as shown in Fig. 9. This type provides two edges which will accommodate four different scales. A better type is the one shown in Fig. 10, which has four bevels and will accommodate eight scales, which are all that are generally used in an architect's office.

All of these types are also made with the bevels faced with white celluloid upon which the markings are engraved. This type and the method of marking facilitate the reading of the marks. The standard length of a scale is 12 inches, but scales that are about 6 inches and 18 inches in length are also sold.

57. Markings on a Scale.—In order that the scale shall be useful in laying out drawings to different scales, all these scales should be shown along its edges. In Fig. 7 is shown an illustration of a scale 6 inches long having scales on four edges. On the side *a* are shown the scales of $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, and 1 inch to the foot. On the side *b* are found the scales of $\frac{3}{8}$ and $\frac{3}{4}$ inch to the foot, and also the scales of $1\frac{1}{2}$ and 3 inches to the foot.

The scale of $\frac{1}{8}$ inch to the foot is shown on the upper edge in *a*. To the left of the 0 mark is $\frac{1}{8}$ of an inch, divided into 12 parts, each of which represents 1 inch if $\frac{1}{8}$ inch represents 1 foot. To the right of the 0 point is a series of $\frac{1}{8}$ -inch divisions, each of which represents 1 foot. Every fourth one of these division marks has a number showing the distance in $\frac{1}{8}$ inches, or feet, from the 0 mark.

In order to read a dimension such as 8' 6'', using this scale, the 8-foot mark must be at one end of the dimension and the other end will be at the 6-inch mark, as shown. Likewise the distance 16' 9'' is determined by making a point at the 16-foot mark to the right of 0 and at the 9-inch mark at the left of 0, as illustrated.

The 1-inch scale is shown on the lower edge of (*a*). The inch to the right of the 0 is divided into 12 parts and marked 3,

6, and 9. The 12 is not marked, as this is not necessary. These inches are subdivided into halves and quarters. If a draftsman has a very sharp point on his pencil, he can point off $\frac{1}{4}$ inch at this scale. Several small dimensions are shown in the figure illustrating the way of reading them. If a dimension such as $\frac{7}{8}$ inch is to be drawn, point off three $\frac{1}{4}$ -inch spaces and half of the fourth quarter inch, as illustrated, and $\frac{7}{8}$ inch will be obtained. The subdivisions finer than those given on the scale must be *measured by the eye*. The possible error is bound to be very small.

The 3-inch scale is shown on the upper edge in (b). The 0 point is at the middle of the scale, and the 1 foot from *a* to *b* is divided not only into inches marked by 3, 6, and 9, but also shows $\frac{1}{8}$ inch at the 3-inch scale. Thus, it is comparatively easy to lay off such distances as $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ inch, as shown at *c*. It is also very easy to lay off distances such as $\frac{7}{8}$, $1\frac{3}{8}$, and $1\frac{7}{8}$ inches, as shown at *d*. It will be observed that the feet are not all numbered in any of these scales. Thus, in the $\frac{1}{8}$ -inch scale every fourth foot is numbered, and in the $\frac{1}{2}$ -inch scale every second foot is numbered. This may cause confusion in reading or laying off distances, and must be carefully watched. Thus, in reading 7 feet on the $\frac{3}{8}$ -inch scale the 7-foot point will be marked 3. This 3 refers to 3 feet on the $\frac{3}{4}$ -inch scale. The line marked 3 is, however, between the 6 and 8 marks of the $\frac{3}{8}$ -inch scale and is, therefore, the 7-inch mark for that scale.

58. Spacing With the Scale.—In addition to its use in scaling, the scale is generally used by experienced draftsmen in preference to the dividers in dividing lines and spaces into equal parts. This process is illustrated in Fig. 19. If it is desired to divide the distance between the points *a* and *b* into ten equal parts, draw lightly with the T square and triangle two parallel lines *ac* and *bd* through the points *a* and *b*. Select any convenient scale in which ten parts are longer than the distance between *a* and *b*, and place the 2 mark on one line and the 12 mark on the other, as shown. Mark the parts between 2 and 12 with the point of a sharp

pencil, as shown, and through these points draw lines parallel to $b d$. These will intersect the line $a b$, dividing it into ten equal parts. In dividing this line into an equal number of parts with the dividers, it is often necessary to make several trials before the line can be equally divided.

The process just described is applicable in dividing the distance between any two parallel lines, such as $a c$ and $b d$, into equal parts.

59. Method of Using Scale.—

In order that the method of using the scale may be clearly grasped, an example of its use is given in Fig. 20. This figure shows the plan of a bedroom that has been drawn to a scale of $\frac{1}{4}$ inch

to the foot. The plan of the room, instead of being drawn out to its actual size, is made so that $\frac{1}{4}$ inch represents 12 inches of actual length.

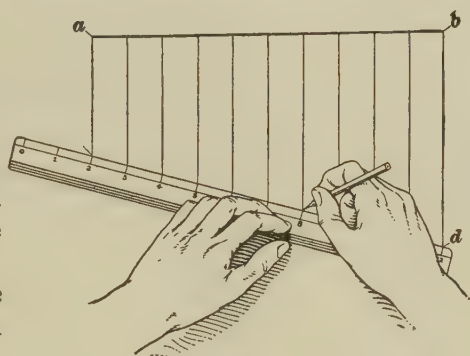


FIG. 19

In the wall d is shown the window c . A scale is shown lying beside this wall. The distance from the corner of the wall to the side of the window is from the 6 mark to the 3 mark on the scale. This shows that this distance is 3 feet. The width of the window shows three $\frac{1}{4}$ -inch divisions and eight of the small divisions to the right of the 0 mark. These divisions being twelfths of a quarter of an inch, will show inches at the scale of $\frac{1}{4}$ inch to the foot. The width of this window is, therefore, 3 feet 8 inches. By applying the scale to the window b in the wall a it also is found to be 3 feet 8 inches in width. The width of the closet may be scaled as shown at the upper part of the drawing and will be found to be 3 feet 10 inches in width. In actual work, the scale is placed close up against the lines to be measured instead of at some distance away from them, as shown in the figure.

FIG. 20

60. A dimension is laid off on a drawing as in the following example:

EXAMPLE.—Lay off a distance of 8 feet 7 inches on a straight line.

SOLUTION.—Mark the point on the line from which the measurement is to be made. At this point place the 8 mark of the scale. The distance from this point to the 0 mark will represent 8 feet. Count off seven of the small inch divisions and make a mark. This will be 8 feet 7 inches from the first mark on any scale that may be used.

To measure off any distance between two points on a plan, such as 6 feet 9 inches, first measure roughly to find out the distance to the nearest foot. In the case under consideration it will be between 6 feet and 7 feet, or the distance will be 6 feet and some inches. Place the 6-foot mark at one of the points and read off at the other point the number of inches, which will be 9. The distance will then be read 6 feet 9 inches.

DRAWING LESSONS

PLAN OF WORK

61. The drawing work of this Section consists of five drawing plates, some of which are made up of several exercises. These drawing plates are to be made by the student according to the detailed instructions given for each, and they are to be sent, one at a time, to the Schools for correction and criticism.

The first of the five plates the student is required to draw consists of four exercises, an exercise in lettering, an exercise in drawing symbols for various materials, an exercise in drawing the elementary parts of a plan to a scale of $\frac{1}{4}$ inch to the foot, and an exercise showing various fixtures that are generally indicated on working drawings.

62. Plate II consists of but one exercise, which is a detail of a cellar window and water-table drawn to a large scale. It is customary in architectural drawing to draw some of the more important details of a building to a large scale, and a beginner will find it easier to make drawings to a large scale

than to a small scale; besides, in this way he will become more familiar with the details of construction as shown at a small scale in working drawings.

Plates III, IV, and V also consist of details of parts of a building and these complete the required drawing work of this Section. (Following these exercises will be found instruction for practice work, which will be found helpful in preparing for the drawing work of the following Section. The practice work is not to be sent in for criticism.)

The method followed in all these drawings will be, so far as possible, the one employed in most architects' offices, so that a person who has studied conscientiously and mastered the instructions given will find himself familiar with the work and methods used in such offices and will also be able to make a set of drawings that will be readily understood by any competent builder or contractor.

DIRECTIONS FOR SENDING IN WORK

63. The plates are to be sent to the Schools one at a time as they are completed. When you finish Plate I send it to us and then begin work on Plate II. When your first plate is received it will be examined and returned to you promptly with corrections and such suggestions as will aid you in the subsequent work. These corrections and suggestions should receive your careful consideration. In this way you will make better progress than you could otherwise.

It is very important that you comply strictly with the directions. Do not be discouraged if there are a large number of corrections on your early plates. We are merely pointing out ways in which the drawing or lettering can be improved so that your later plates may be as nearly perfect as they can be made. No one can obtain proficiency unless the work is criticised, and we will do our best to help you succeed. We should not be doing our duty if we did not point out the defects. The *number* of corrections is no indication of our opinion of the merits of the drawing.

On all plates that you send to us, write your name and address in full in lead pencil on the back of the plates. This should in no case be omitted, as delay in the return of your work will otherwise surely occur.

PLATE I, TITLE: LETTERING AND INDICATIONS

64. General Directions.—Cover the surface of the drawing board with a piece of smooth heavy paper and on top of this tack a sheet of tracing paper about 16 in. $\times$ 22 in. in size. Lay off with the pencil the outer lines, as shown on the layout for Plate I, making a rectangle 15 in. $\times$ 20 in. in size. One-half inch inside this rectangle draw the *trimming line*, and 1 inch in from the trimming line draw the *border line*. Lay out the panels *a*, *b*, *c*, and *d* according to the dimensions shown on the plate. After all the lines have been drawn, measure the dimensions once more to make sure that they are correct and proceed with the exercises. All these lines should be drawn very lightly so as to be barely visible. The border line may then be strengthened by drawing it with a firm even pressure of the pencil point on the paper.

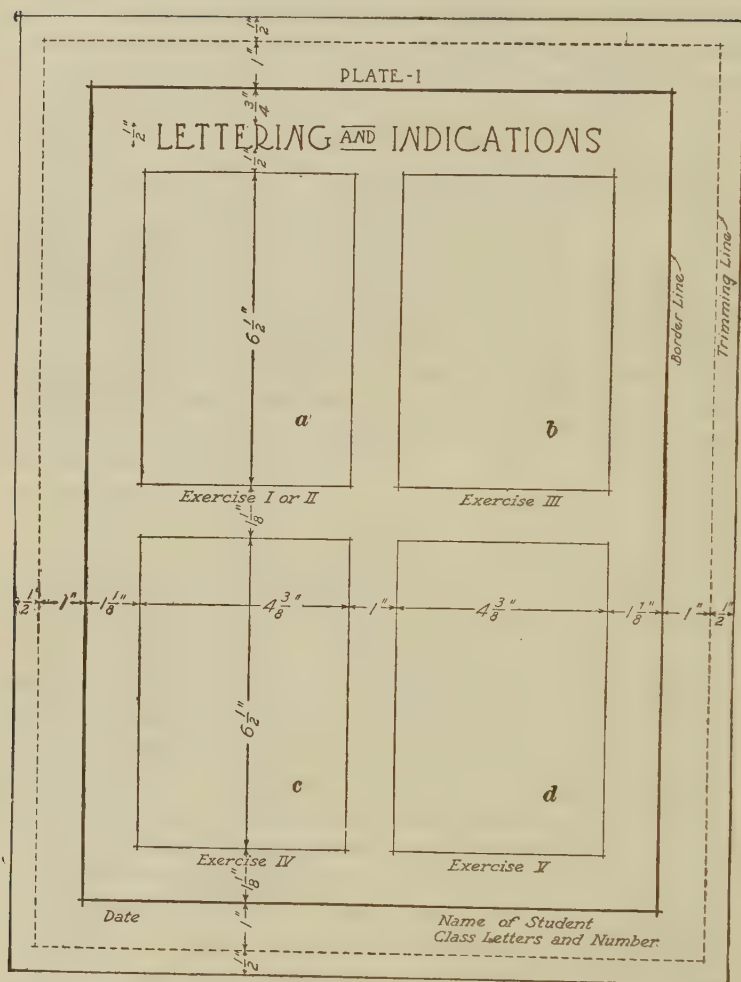
The lines that are drawn lightly are needed only as guides in laying out the drawing and can be easily erased when the drawing is finished and is being cleaned up at completion.

The panels *a*, *b*, *c*, and *d* of Plate I are to be filled in with four of the five exercises shown in the following pages. Exercise I shows a slanting style of lettering and Exercise II shows a vertical style. The student may follow the style of lettering he prefers, and place this in panel *a*. Exercise III is to be placed in panel *b*, Exercise IV in panel *c*, and Exercise V in panel *d*.

The space between the upper border line and the panels is for the title, as shown in the layout of Plate I.

The space between the lower border and trimming lines is for the student's name, class letters and number, and the date, as shown in the layout for Plate I. It is important that this information be given, for if the name, class letters and

LAYOUT FOR PLATE



number are omitted, the drawing cannot be identified readily, and there is sure to be a delay in the return of the corrected lesson.

The drawings are to be made first in pencil on tracing paper and then traced on tracing cloth in ink. Both copies are then to be trimmed as indicated in the illustration headed Layout

EXERCISE I, PLATE I

A B C D E F G H

I J K L M N O P

Q R R S S T U V W

W X Y Z & & X U

A B C D E F G H I J K L M N O

P Q R R S S T U V W X Y Z & & U

1 2 3 4 5 6 7 8 9 0 $\frac{1}{2}$ $\frac{3}{8}$ $\frac{5}{16}$ 3-4 $\frac{7}{8}$ 7

A B C D E F G H I J K L M N O P Q R R S S T

U V V W W X X Y Z 1 2 3 4 5 6 7 8 9 0 $\frac{3}{32}$

a a b c d e f g h i j k l m n o p q r s t u v w x y z etc.

used always in panel form comma &

USE THIS ALPHABET FOR TITLES ETC. O

N PLANS & ELEVATIONS A PR

for Plate I, and sent to the Schools for examination and criticism. The character of both the pencil and the pen work will be considered in giving a percentage mark on the work.

65. Exercise I or II.—The first exercise is one in lettering, which may be either the vertical style of Exercise I or the slanting style of Exercise II. These illustrations show both capital and lower-case letters in several sizes and of a freer character than those shown in *Geometrical Drawing*. In these styles the ends of letters are made with small strokes, called ceriphs, which give the letters a finished appearance. On drawings, capital letters should be used for titles and lower-case letters for explanations and notes.

Good lettering on drawings is of the greatest importance. Many good drawings are spoiled by poor lettering. The slanting style of lettering is easier to learn than the vertical style, but whichever style is adopted, the student should practice making that style. The practice work should be on separate sheets of paper, and the lettering on the drawing should not be made until the student is thoroughly proficient in this.

In this practice work as well as in the finished drawing it is important to draw guide lines as explained in *Geometrical Drawing*.

In this work, the lettering is to be made the same sizes as shown in the accompanying pages of Exercises I and II. While working on the exercise of panel *a*, the other parts of the drawing should be covered with a piece of paper, and when one panel is completed it should be covered and another panel uncovered. The entire drawing should be covered if work is stopped for any length of time.

66. Exercise III.—In making a drawing in which it is necessary to show several different materials, and when it is desirable to make prints from the drawing, these different materials are indicated by certain conventional symbols as are shown in Exercise III. These symbols vary in different offices, but the ones shown will be found to be satisfactory. As has been stated, a key or series of parallelograms contain-

EXERCISE II, PLATE I

A B C D E F G H

I J K L M N O P Q

R R S S T U V W W

X Y Z & & 9 X X

A B C D E F G H I J K L M N O P

Q R R S S T U V W W X Y Z &

9 & X X 1 2 3 4 5 6 7 8 9 0 $\frac{1}{2}$ $\frac{3}{8}$

A B C D E F G H I J K L M N O P Q R R S S T U W W

X X X Y Z 1 2 3 4 5 6 7 8 9 0 $\frac{3}{16}$ $\frac{5}{8}$ ALPHABI

a a b c d e f g h i j k l m n o p q r s t u v w x
x y z etc one quarter inch scale e

THIS STYLE OF LETTERING FOR
RAPID LETTERING ON PLANS &

SYMBOLS FOR MATERIALS

IN PLAN & SECTION

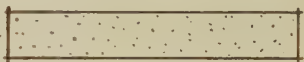
IN ELEVATION



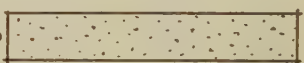
a BRICK m



b STONE,
PLASTER
OR STUCCO n



c CONCRETE o



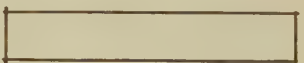
d MARBLE p



e TERRA COTTA q



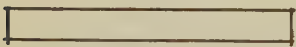
f WOOD r



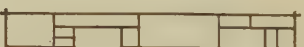
EARTH



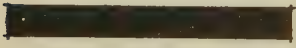
RUBBLE STONE WALL



WOOD AND PLASTER
PARTITIONS AND WALLS



ROCK-FACED ASHLAR



ALTERNATE FOR WOOD
& PLASTER PARTITIONS



SHEET METAL



WOOD BLOCKING
AND TIMBERS j



STRUCTURAL STEEL
IN SECTION



SHEET METAL k



STEEL BEAMS OVER l

NOTE: CONTRACTOR SHALL
VERIFY ALL DIMENSIONS
BEFORE PROCEEDING WITH
THE WORK AT THE BUILDING

ing all the symbols used should be made *on every working drawing*. This will prevent any misunderstanding of their significance in that drawing. In drawing these symbols on Plate I they should be made exactly the same size as given. The use of these symbols is illustrated in the working drawings shown later. The note given at the bottom of the exercise is generally put on drawings so that the work of one contractor shall fit the work already done by another contractor. The letters *a*, *b*, *c*, etc., used in referring to the various indications, need not be shown on any of these exercises. The other lettering should, however, be drawn on the plate.

67. Exercise IV.—A plan is made up of curved and straight lines, all of which are drawn to indicate parts of buildings, such as walls, windows, doors, closets, etc. A series of the most common of these indications is given in this exercise. The arrangement of lines used to show various kinds of doors, windows, fireplaces, and closets are here shown, and by drawing these elementary parts of the plan the beginner will be familiar with them when he comes to make working drawings.

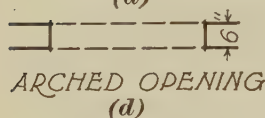
In drawing these indications, they should be made at the scale of $\frac{1}{4}$ inch to the foot, which is the scale at which they are shown in the cut. The lines should be made as nearly as possible of the same thickness as those shown, and the snappy, vigorous character of these lines should be copied. At the corners the lines should be carried slightly beyond the intersection so as to form positive corners. The dimensions shown in the cut are to be used as a guide in laying out the various indications on the plate. The scale should be used to measure off the lengths of various parts, and the distances should be laid out on the drawing, and the same scale used. This exercise in the use of the scale will be of the greatest value later on in the work.

68. Exercise V.—Another series of indications that are used to show various plumbing fixtures on architects' drawings are shown in Exercise V. Various types of bath tubs, showers, wash basins, sinks, laundry tubs, water closets, etc.

EXERCISE IV, PLATE I



DOUBLE HUNG WINDOW
(a)



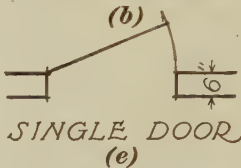
ARCHED OPENING
(d)



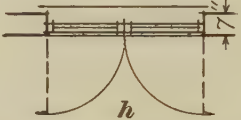
CASEMENT WINDOWS
OPENING OUT
NOTE: FRENCH DOORS ARE SHOWN
SAME AS CASEMENT WINDOWS



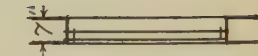
HIGH WINDOW
(b)



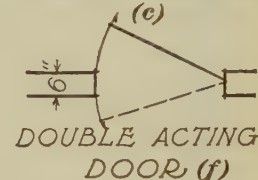
SINGLE DOOR
(e)



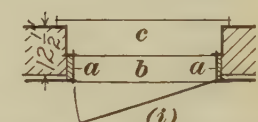
(h)



SINGLE WINDOW
(c)



DOUBLE ACTING
DOOR (f)



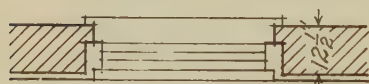
SINGLE DOOR
IN BRICK WALL
(i)



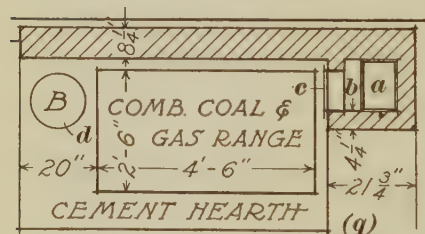
DOUBLE SLIDING DOOR
(j)



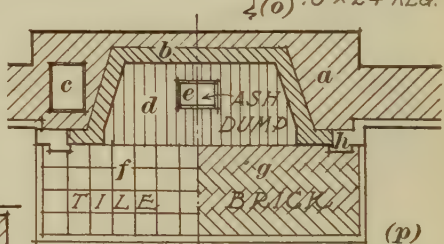
SINGLE SLIDING DOOR
(k)



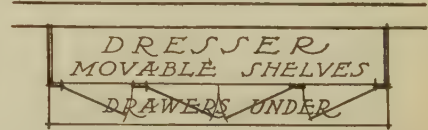
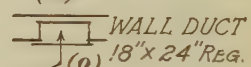
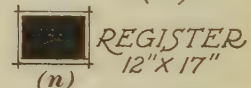
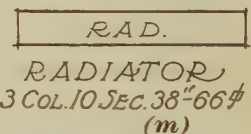
DOUBLE HUNG WINDOW
IN BRICK WALL (l)



RANGE AND BOILER
(q)

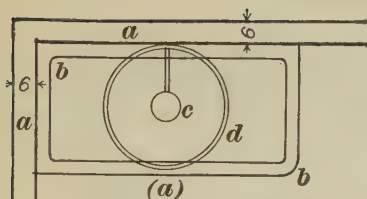


FIRE PLACE
(p)

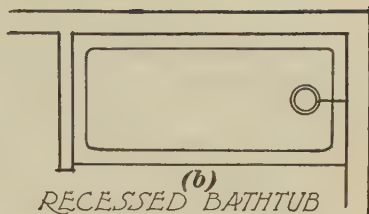


DRESSER (r)

EXERCISE V, PLATE I

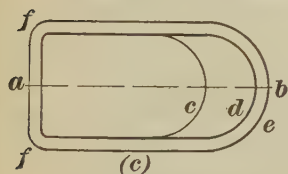


LEFT-HAND CORNER
BATHTUB

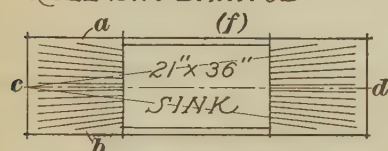


RECESSED BATHTUB
WITH SHOWER AT END

NOTE: RIGHT-HAND CORNER
BATHTUB REVERSED



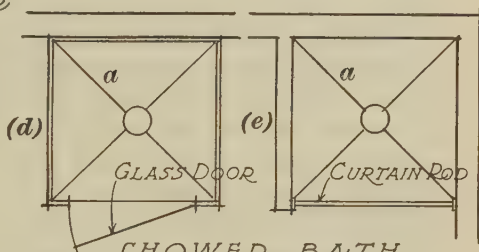
ROLL RIM BATHTUB



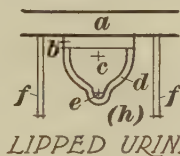
KITCHEN OR PANTRY SINK
WITH DRAIN BOARDS



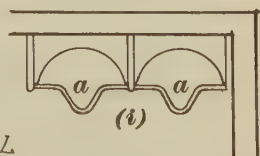
MEDICINE CLOSET



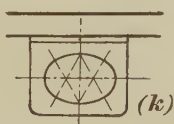
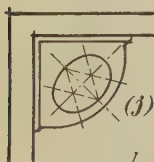
SHOWER BATH
MARBLE-STALL SHOWER BATH
WITH GLASS DOOR
BUILT IN SHOWER BATH
WITH CURTAIN ROD



LIPPED URINAL



STALL URINAL

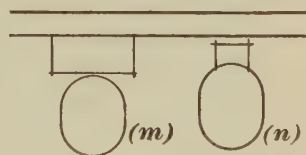


LAVATORIES

(j) CORNER LAVATORY

(k) STRAIGHT FRONT LAVATORY

(l) OVAL LAVATORY

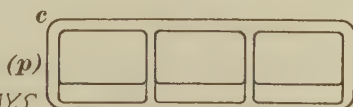


WATER CLOSETS



(o)

LAUNDRY TRAYS



(p)

are given. As one or more of these indications are used on every plan, it is necessary to be familiar with them all. The customary sizes are shown in this exercise at $\frac{1}{4}$ inch to the foot, the scale generally used in working drawings.

In drawing the bath tub (*a*), first lay out the lines of the partitions at *a*, making them 6 inches in thickness. Next draw the outside line of the tub and the rectangle showing the inside lines of the tub. Draw the small curved corners *b* freehand, so that these curved lines shall meet the ends of the straight lines. A shower is indicated at *c* and a rod from which a curtain is suspended is indicated at *d*.

In drawing the bath tub (*c*) draw the axis line *a b*. Then draw the semicircles at *c*, *d*, and *e*, after which finish the straight lines and make the small curves *f* freehand.

The drain boards of the sink (*f*) show the grooves radiating from the points *c* and *d*. These points can be formed by extending the two outside lines on each drain board, as *a* and *b*, until they intersect. This intersection should be upon a line *c d*.

The urinal (*h*) is shown by drawing against the wall or partition *a*, the rectangle *b*, making it about 5 in. $\times$ 18 in. From

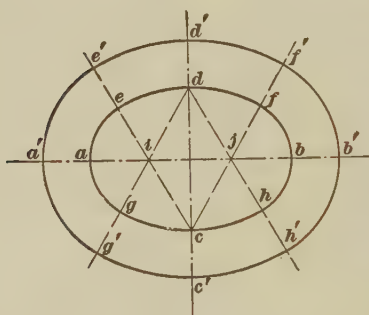


FIG. 21

the point *c* as a center and with a radius of 9 inches, draw a semicircle *d*. With *e* as a center, draw a semicircle with a radius of about 3 inches. Draw two additional semicircles inside the first. Connect these parts of circles, as shown, by freehand curves. Draw all these lines faintly at first and then put in the desired lines firmly and re-

move the unnecessary lines with a soft eraser.

To draw an indication of an oval basin (*l*), a method is shown in Fig. 21. Draw the axes *a b* and *c d* of the basin perpendicular to each other. Make the width *c d* of the bowl equal to 12 inches. With *c* and *d* as centers and with a radius

equal to cd , draw the arcs ef and gh . Draw lines at 60° with ab , through c and d . Where these lines intersect the axis at i and j , will be the centers for the end curves. Make the distances cc' and dd' about 4 inches, and with the radius cd' draw the curves $e'f'$ and $g'h'$, and with the radius jf' draw the curves $f'h'$ and $e'g'$. If the work is carefully done, a satisfactory double oval will result.

The ovals in the other basins (j) and (k), as well as the seats of the water closets (m) and (n), can also be drawn in this manner. The seats of (m) and (n) may be drawn as shown by making two semicircles and connecting them by straight lines. In (o) and (p) are shown indications of laundry tubs, or trays. In (o) is shown a set of three tubs made of wood, slate, or soapstone, the material being about $1\frac{1}{4}$ inch thick, and at (p) is shown a set of three porcelain tubs. In the latter the material is about 3 inches thick, and should be so shown. The corners are rounded with freehand curves. Practice in drawing these exercises will be very profitable, and the thickness, as well as the firmness and strength of these lines, should be closely imitated.

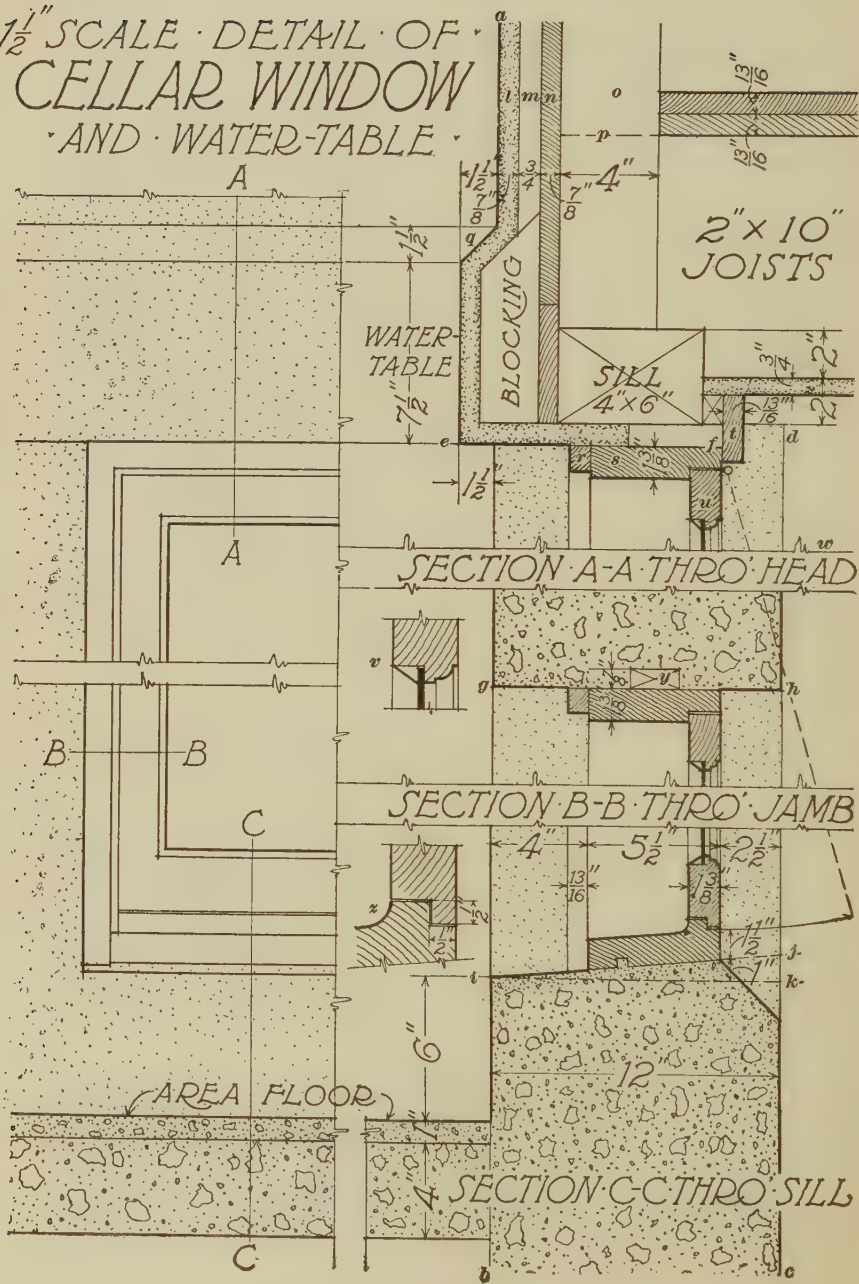
PLATE II, TITLE: DETAIL OF CELLAR WINDOW AND WATER-TABLE

69. Cellar Windows.—Features of importance in both the design and the construction of a building are the windows and doors. It is necessary that the draftsman have a thorough knowledge of the way that they are made. He will then be able to show them intelligently on the small-scale plans and elevations of the working drawings as well as to detail them on a larger scale for the guidance of the workmen in the mill in getting them out.

70. In commencing the construction of a building from the $\frac{1}{4}$ - or $\frac{1}{8}$ -inch scale working drawings, one of the first details that will be called for by the contractor is that of the cellar windows, as they are set in the cellar wall and are, therefore, the first frames required.

EXERCISE I, PLATE II

$1\frac{1}{2}$ " SCALE · DETAIL · OF ·
CELLAR WINDOW
· AND · WATER-TABLE ·



71. Plate II will consist of one exercise, which will be drawn to the scale of 3 inches to the foot, or one-quarter full size. The plate as given is shown at the scale of $1\frac{1}{2}$ inches to the foot. All the dimensions on the drawing will, therefore, be twice the size of those shown.

72. Exercise I.—Having covered the surface of the drawing board with a piece of heavy paper, tack on the top of this a piece of white tracing paper 16 in. $\times$ 22 in. in size and lay off the border lines as in Plate I, but instead of drawing the four rectangles *a*, *b*, *c*, and *d*, leave this space clear for Plate II. Draw the vertical line *ab*, in Exercise I, $5\frac{1}{2}$ inches to the left of the right-hand border line. Draw this line lightly, as certain portions of it will have to be erased later. Next draw *cd* vertically and 3 inches to the right of *ab*. Draw the line *ef* $6\frac{1}{2}$ inches from the upper border line, and *gh* 9 inches from the upper border line. Dot in the line *ik* $5\frac{1}{2}$ inches below the line *ef*. The inches mentioned so far are actual inches which may be found on the inch scale. Having established the lines just drawn, *the remainder of the drawing is laid out, using the 3-inch scale only.* The dimensions of the various parts of the detail are marked on the plate in the book for the convenience of the beginner and as a rule do not appear on a practical detail. It will be found to be excellent practice in the use of the scale to measure off dimensions on the plate in the book at $1\frac{1}{2}$ inches to the foot, and lay them out on the plate at 3 inches to the foot. Fig. 22 is a perspective view of this window and will help in understanding the meaning of the lines in Exercise I.

73. Starting with the water-table and head of the window and having the line *ab* drawn in lightly, lay off $\frac{7}{8}$ inch at the 3-inch scale for the stucco *l*, $\frac{3}{4}$ inch for the furring *m*, $\frac{7}{8}$ inch for the sheathing *n*, and 4 inches for the studs *o*, and draw lightly four vertical lines. Draw a line parallel to and $\frac{7}{8}$ inch above *ef*, which gives the bottom line of the sill of the framework of the building resting upon the cellar wall. Measure up 4 inches for the top line of the sill and in from the sheathing 6 inches for the back of the sill. At 8 inches above

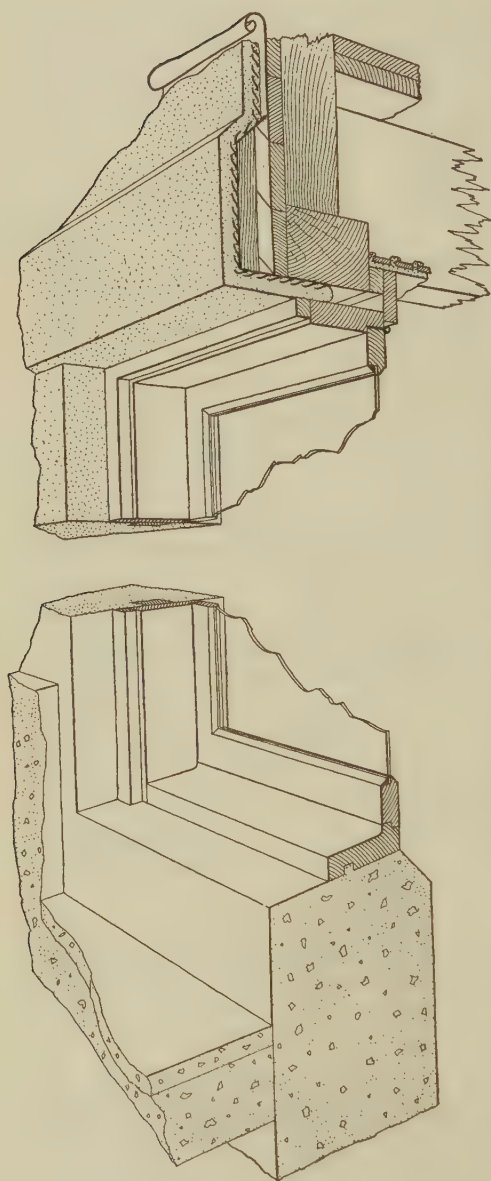


FIG. 22

the top of the sill draw the top line of the floor joists. Show the two thicknesses of floor on top of the joists, making them $\frac{1\frac{3}{8}}{1\frac{3}{8}}$ inch each. The joist is shown extending out to the sheathing by a dotted line *p*. The dotted line is drawn because the joist is assumed to be on the far side of the stud *o*. The bottom line of the joist will be 2 inches below the top of the sill and the plastering on the under side of the joists is $\frac{3}{4}$ inch thick. The water-table projects $1\frac{1}{2}$ inches beyond the line *ab*. Draw this vertical line $7\frac{1}{2}$ inches above the line *ef*, and with the 45° triangle draw the slanting line *q*. Make the stucco $\frac{7}{8}$ inch thick, as shown, and the water-table, sill and joists can then be drawn in with firm, clean lines. As shown in the symbols given in Plate I, Exercise III, stucco is shown by dotting thickly

where it is in section. The sheathing, being wood, in cross-section, is hatched with freehand lines slightly curved, as shown in *f*, Plate I, Exercise III.

74. The head of the window frame is made by laying off the horizontal dimensions as shown on the section through the window sill below. Lay the scale just below the line *ef*, and from the line *ab* lay off 4 inches, $5\frac{1}{2}$ inches, and $\frac{1\frac{3}{8}}{16}$ inch, marking these dimensions off by points or marks with a sharp pencil. Then with the triangle on the square draw light vertical lines through these marks. Make the staff bead *r* $\frac{1\frac{3}{8}}{16}$ inch thick by $1\frac{1}{8}$ inch deep, the head *s* of the frame $1\frac{3}{8}$ inches, and the rabbet in the head, which receives the sash, $\frac{1}{2}$ inch. The inside piece *t* is kept up from the sash opening about $\frac{1}{4}$ inch to avoid the knuckle of the hinge. The sash *u* is made of $1\frac{1}{2}$ -inch stuff and when finished measures about $1\frac{3}{8}$ inches. A section

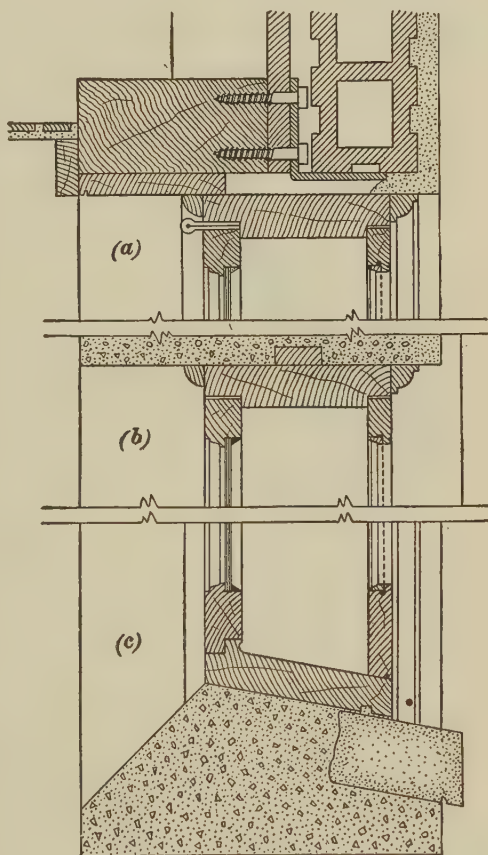


FIG. 23

through this sash is shown at a larger scale at *v*, so as to give a clear idea of its shape. The broken line *w* is placed just below the sash to terminate the section.

There should be no difficulty in drawing the plan of the jamb, as most of the vertical lines can be projected downwards. The piece of wood *y* is nailed to the jambs of the frame and extends for the entire height of the frame. It is embedded in the concrete wall and occurs on both sides of the frame.

The sill of the window is shown at a slope. It is built in this way to shed the rainwater. Lay off a distance of 1 inch

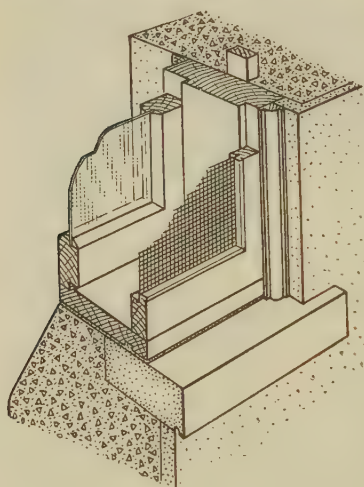


FIG. 24

from *k* to *j* and draw *ij*. Scale off the wooden sill and draw it as accurately as possible. The rabbet in the sill is shown at a larger scale at *z*.

The elevation is merely a projection from the sections and should present no difficulty. When all the lines are carefully located, they should be drawn in firmly in pencil and the indications of materials next put in according to the system of symbols given in Plate I, and as shown in the plate. Finally, the lettering should be drawn. This

should be done with great care so that the drawing may not be spoiled. The dimensions need not be placed on the drawing.

75. When the drawing is complete, place a piece of tracing cloth over it, rub powder over the surface, dust off the loose powder, and make an ink tracing, drawing in the border lines and lettering the plate with the title, the student's name, class letters and number, and the date.

It will be observed that in each of the sections the outline of the section is drawn in extra-heavy lines. This may be omitted if it is desired. This treatment, however, adds to the style and finish of the drawing and is frequently used by good draftsmen.

This drawing can be made as a full-size detail by drawing it out on a large piece of paper at four times the size of the 3-inch scale plate. The detail of the larger scale at *v* and *z* should, however, be omitted. When lettering Plate II just drawn it should be marked 3" Scale Detail. The plate shown is at the scale of $1\frac{1}{2}$ inches to the foot.

76. A cellar window is shown in Fig. 23 in which a mosquito screen is used. The wall above is of terra cotta and is plastered. The terra cotta is supported on an angle-iron lintel which is fastened to the sill by lagscrews. In (*a*) is shown the head; in (*b*) the plan of the jamb, and in (*c*) a section through the sill. Fig. 24 shows a perspective view of the sill and jamb of this window.

PLATE III, TITLE: DOUBLE-HUNG WINDOW IN FRAME WALL

77. Plate III.—Plate III consists of one exercise, which is a detail of an ordinary double-hung window in a frame wall, as shown in Fig. 25. The plate is to be first drawn out on tracing paper, after which it is to be carefully traced on tracing cloth in ink. The border lines will be made according to the diagram in Plate I. The space used will include the four spaces shown and will be $9\frac{3}{4}$ inches wide and $14\frac{1}{8}$ inches in height. This exercise is given at a scale of 2 inches to the foot, and the student is required to draw it at the scale of 3 inches to the foot, or one and one-half times as large.

78. To draw Exercise I, Plate III, draw a light vertical line *a b* $3\frac{1}{2}$ inches, actual size, in from the right-hand border line. This will represent the inside line of the studs. Draw *c d* horizontally and 6 inches below the top border line, also *e f* $9\frac{1}{2}$ inches below the top border line. The line *g h* is practically 12 inches below the top border line. Having these lines to work from and using the 3-inch scale there should be no difficulty in making this drawing. While making this exercise all the dimensions should be measured off from the illustration with

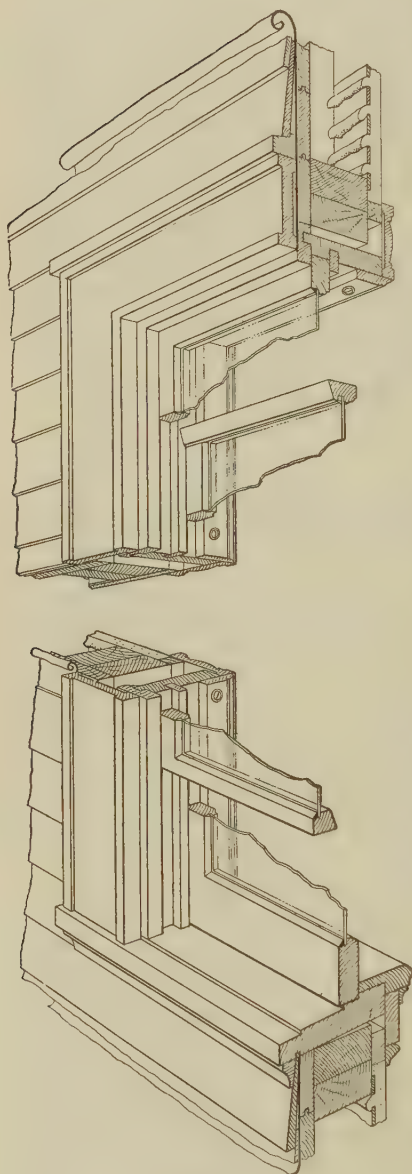
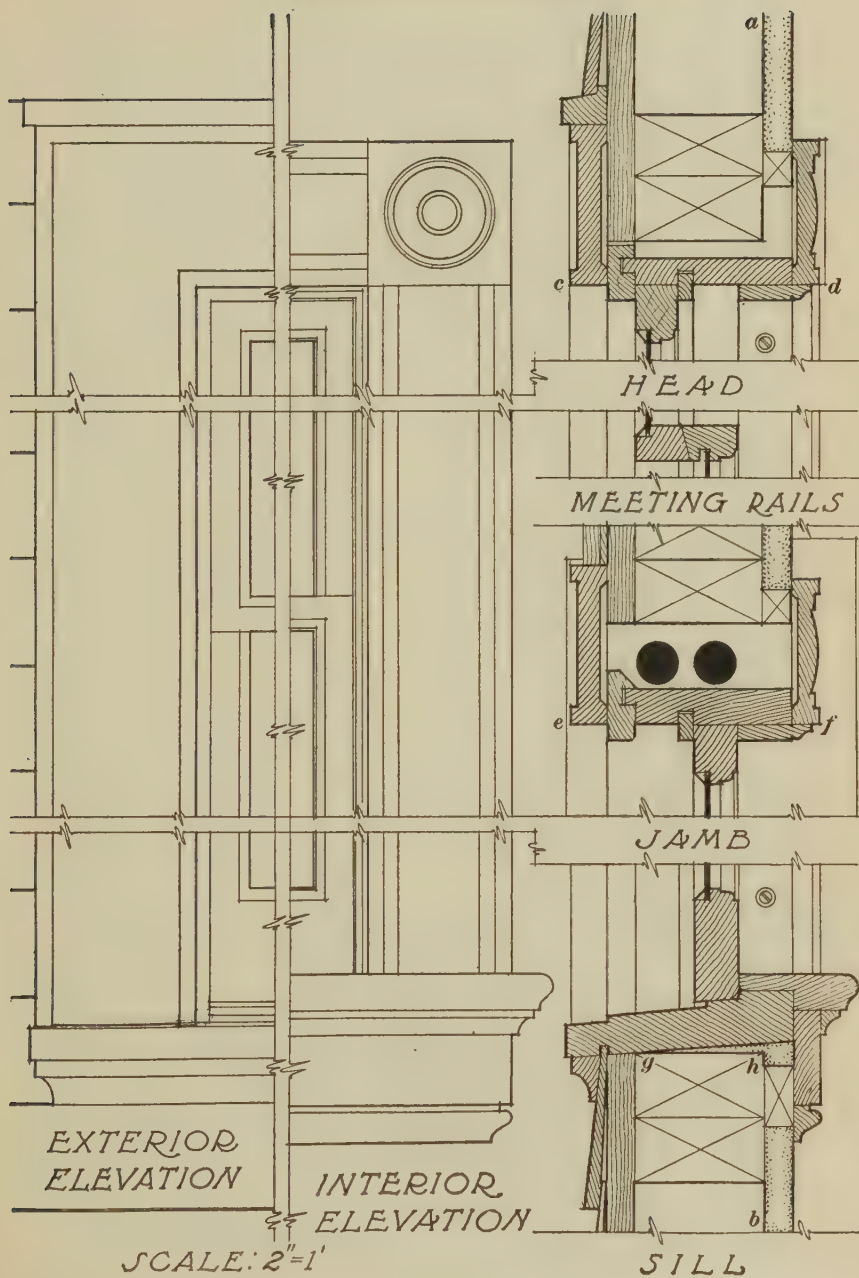


FIG. 25

the scale of 2 inches to the foot and laid off on the plate at 3 inches to the foot. In measuring a dimension on a drawing that is made at the scale of 2 inches to the foot, the dimension is measured with the 1-inch scale and divided by 2. Thus, if the thickness of the studs is to be measured, the 1-inch scale is applied and the width, as at *g h*, is found to be 8 inches. Dividing by 2, the result will be 4 inches, which is the actual size of the stud. Likewise, the vertical dimension of the stud will measure 4 inches at the 1-inch scale. Dividing by 2, the correct dimension will be 2 inches. Facility in the use of the scale, that will be found of great value in drawing, will thus be cultivated. Carefully observe the thickness of the lines in the illustration and make them a little stronger in the plate. Use the T square and triangle in projecting dimensions from one section to another when possible. Thus, the width of the studs should be laid out in the top section and the outside lines carried down to

EXERCISE I, PLATE III



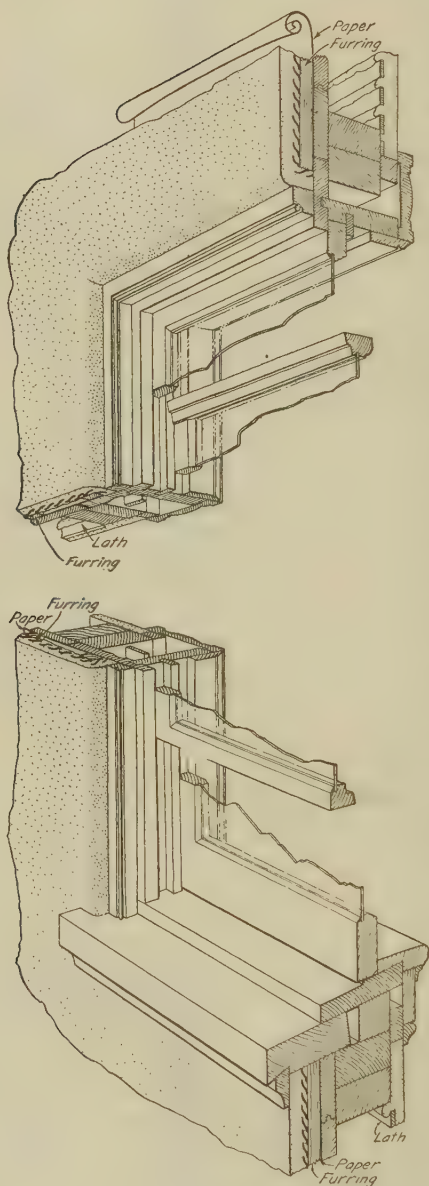


FIG. 26

the sections through the jamb and the sill. The same is done with the sheathing, plaster, etc. If desired, the lines may be made heavier in places, as shown in the illustration of Plate III. This makes a better looking drawing. Draw in the lettering, giving the names of the different sections, etc. of the window, such as jamb, head, etc., but not the small letters illustrating the parts of which the frame is made. When the tracing on cloth is completed it should be cleaned as already described, cut to the proper size, and mailed to the Schools for criticism.

79. Double-Hung Windows in Stuccoed Walls.—When the outside of the frame of a building is finished with a coating of stucco, there are slight differences in the design of the window frames from those used in houses covered with siding or shingles. A window in a stuccoed wall is illustrated in Fig. 26

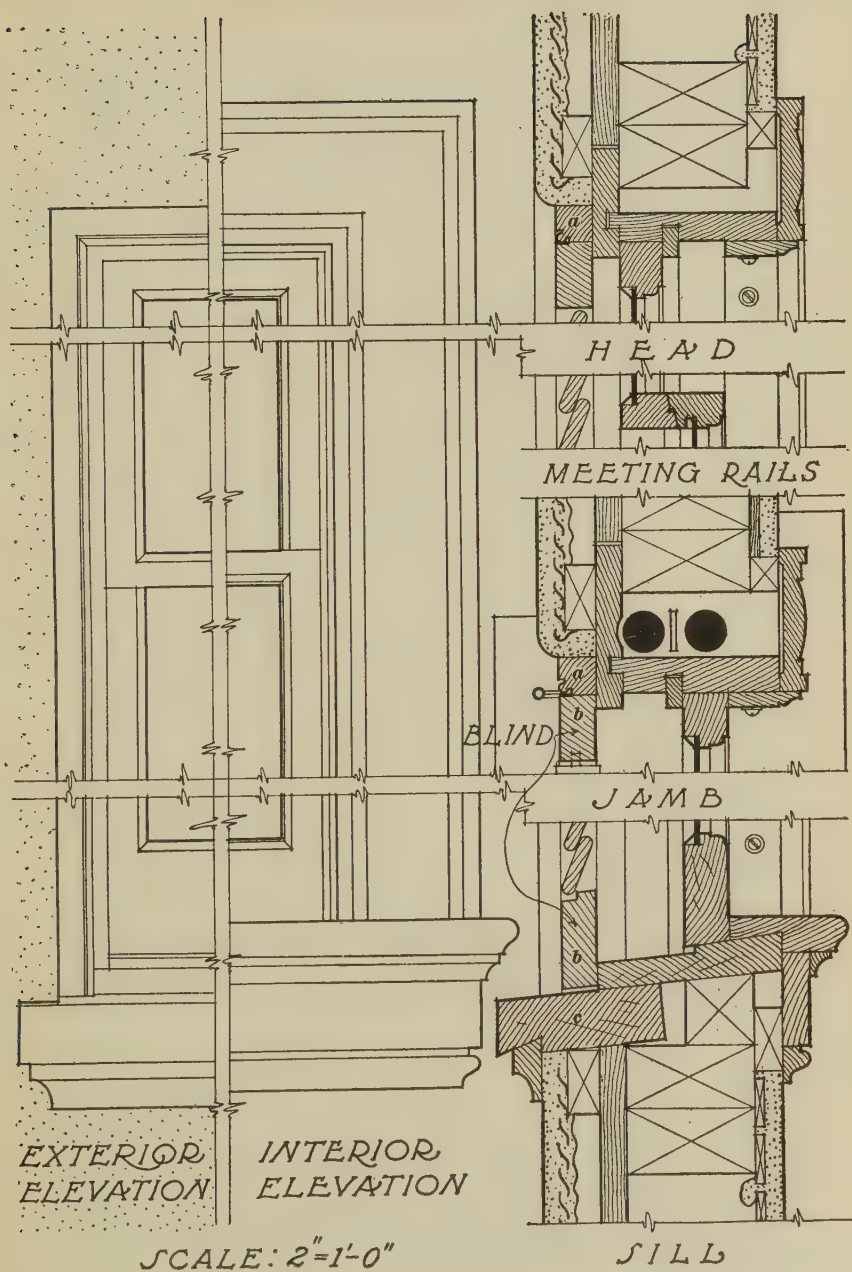


FIG. 27

by means of a perspective view; also in Fig. 27, which is a detail of the same window. The differences will be very evident if Fig. 26 is compared with Fig. 25. The outside architrave is omitted in Figs. 26 and 27, and a blind stop is used as at *a*. Furring strips are nailed on the sheathing and the wire

lath and the plaster are secured to the furring. The plaster is finished against the face of the outside casing and a blind stop *a*, Fig. 27, is nailed in the corner to the windowframe. The blind *b* is shown in place. The sill in the detail is made double, the lower part *c* being called the *sub-sill*.

It is suggested that, for the sake of practice, a detail drawing of a double-hung window such as shown in Figs. 26 and 27 be made. The student will not be expected, however, to send in this drawing to the Schools for correction.

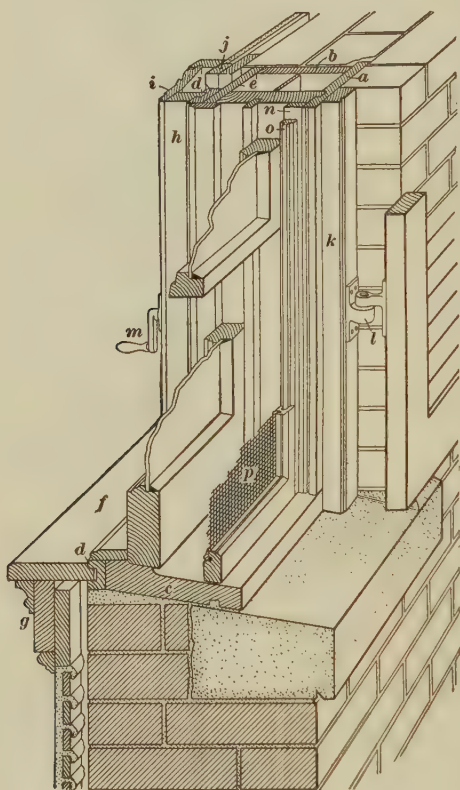


FIG. 28

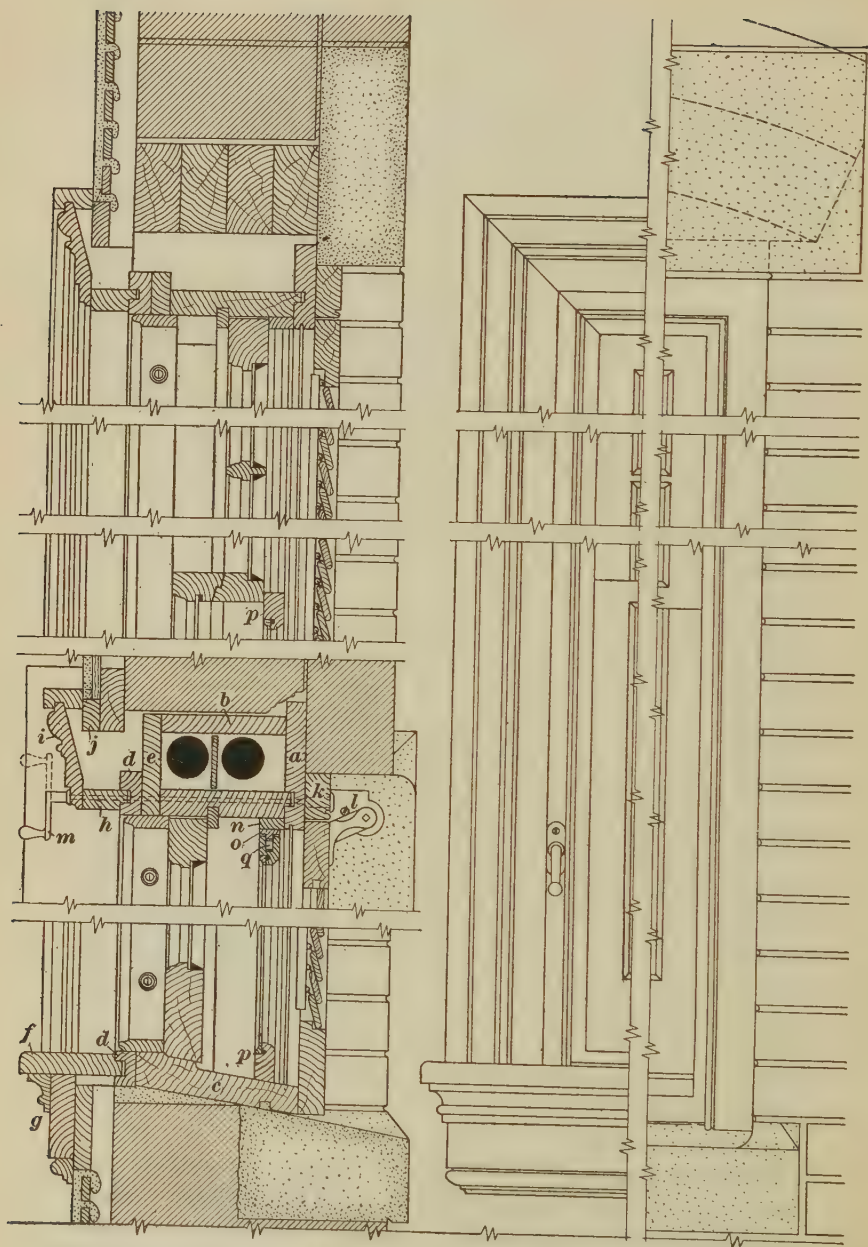
80. Double-Hung Windows in Brick and Stone Walls.—In Fig. 28 is shown a sketch and in Fig. 29 a working detail of a box-frame window suitable for a stone or brick wall. The general design and construction of the frame and sash are similar to that shown in Figs. 25, 26, and 27, the only changes being in parts that require to be adapted to a new

condition. In brick walls it is usual to set the window frames during the erection of the walls, thus facilitating the plumbing of the brick jambs, particular care being taken to brace the frames in order to keep them plumb and level. By extending the outside casing *a*, Figs. 28 and 29, 1 inch beyond the back lining *b*, the frame can be firmly held in place. The sill *c* is made of 2-inch plank. The groove on the bed permits the formation of a mortar tongue if desired, making it practically air-tight. The slightest shrinking and warping of the sill allows the passage of air and water, unless this device is adopted. A $\frac{7}{8}$ -inch finished casing *d* may be attached to the box casing *e*, after the building is ready for trimming. The window stool or seat *f* is tongued into the casing *d*, and is generally finished with a molded apron *g*. The jamb casing *h* is tongued into the finished casing *d*, and the opening trimmed with a casing, or architrave, such as *i*, nailed to the jamb casing *h* and the plaster ground *j*.

The hanging stile *k* in brick-set frames is attached to the frame before setting, but where outside blinds are not used an angle mold may be substituted. Before the window frames are given the final coats of paint, the hanging stiles may be removed and the joint between the frame and the brickwork calked with oakum to make a weather-proof joint, after which the hanging stiles are replaced.

In stone walls, window frames are not usually set until the building is roofed and is prepared for the plastering, or has the plastering completed. There are two reasons for this, the principal one being the difficulty experienced in setting jamb stones and lintels while the frame is in position, and the second that, with all due care, the frames are likely to be more or less damaged during building operations and are never so true to line, level, and plumb as those set in place after the walls are completed.

81. Screens.—Figs. 28 and 29 also show screens and blinds fitted to the frame. Where both blinds and outside screens are used, a special piece *n* is nailed to the pulley stiles and upon this a strip, or track, *o* is fastened, which receives



DOUBLE HUNG WINDOWS IN BRICK BUILDING

the screen *p*. Space must be left between the face of the screen and the inside face of the blind for the rod that is fastened to the slats in the blind, and for the hardware where the ordinary blind fasteners or adjusters are used.

The screens *p* are made with hardwood or metal frames, with a wire mesh stretched tightly over them. The screens are provided with springs *q*, Fig. 29, which are concealed in the grooves at the sides, and will remain stationary in any position.

82. Blinds and Shutters.—Blinds are made with slats, either fixed or movable; shutters are solid and generally paneled. Both blinds and shutters are generally made $1\frac{1}{8}$ inches in thickness and hung on L-shaped hinges, which allow of their clearing a reveal or an outside architrave, and lying flat against the wall of the house. They are secured by blind fasteners or by blind adjusters. Devices by means of which the blinds or shutters may be opened or closed from within the house, without the necessity of opening the window, hold the blind firmly in any desired position. A device of this kind is shown at *l* and *m*. The box *l* contains a worm-gear that is operated by turning the crank *m*, thus opening or closing the blind.

83. Storm Sash.—Storm sash are sometimes provided for windows and are made generally of material $1\frac{1}{8}$ inches thick and are hung in the rabbet that is occupied by the blinds when closed. The blinds are either removed or left open while the storm sash are in place.

84. Casement Windows.—Casement windows are, as mentioned elsewhere, those that have sashes hinged at the sides and that swing in or out like doors. *French windows* are casement windows having two sashes with meeting stiles down the center. They are generally carried down to the floor and are high enough to be used as doors. Casement and French windows are difficult to construct so that rain will not beat in, but as they are very effective from the standpoint of design, different devices have been tried to make

them serviceable. A fairly satisfactory detail of a French window is shown in Figs. 30 and 31, showing the most effective treatment of the sill and jamb, which are the weak features of these windows. The sill should be made of $2\frac{1}{2}$ -inch material and rabbeted and the surface curved as shown at *b*.

85. This feature intercepts rain that is blown against the joint of the sash and the sill. If, however, water should

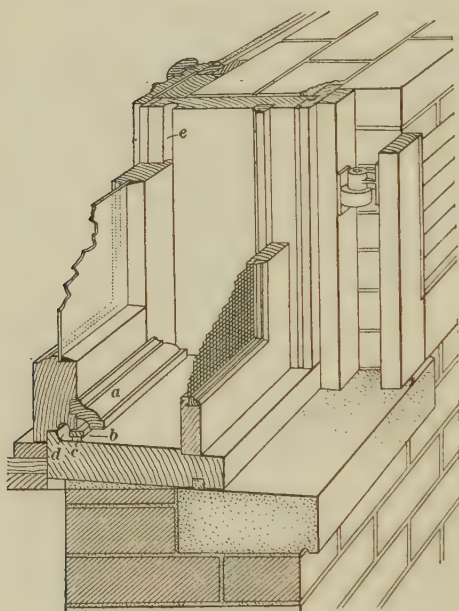


FIG. 30

be forced into the joint it would fall into a gutter *d*, which is plowed in the sill and which is drained, in turn, through the holes *c*, which are about $\frac{3}{8}$ inch in diameter and about 2 inches apart. The drip mold *a* on the bottom rail of the sash also aids in stopping rain that may be blown against the bottom joint and forms a drip for water that washes down the face of the sash. The jambs, instead of having straight rabbets like

those of a door, have semicircular channels worked into them, as shown at *e*, into which a half-round projection on the stile of the sash works. The meeting stiles are designed with beveled rabbets, so that one sash can be opened at a time. *Astragals g*, Fig. 31, are placed on the outside and the inside, so that both shall be on the center. The inside astragal, if the window is to be fitted with *Cremorne* or *Espagnolette* bolts, should have a flat surface, $1\frac{3}{4}$ inches in width, to receive them.

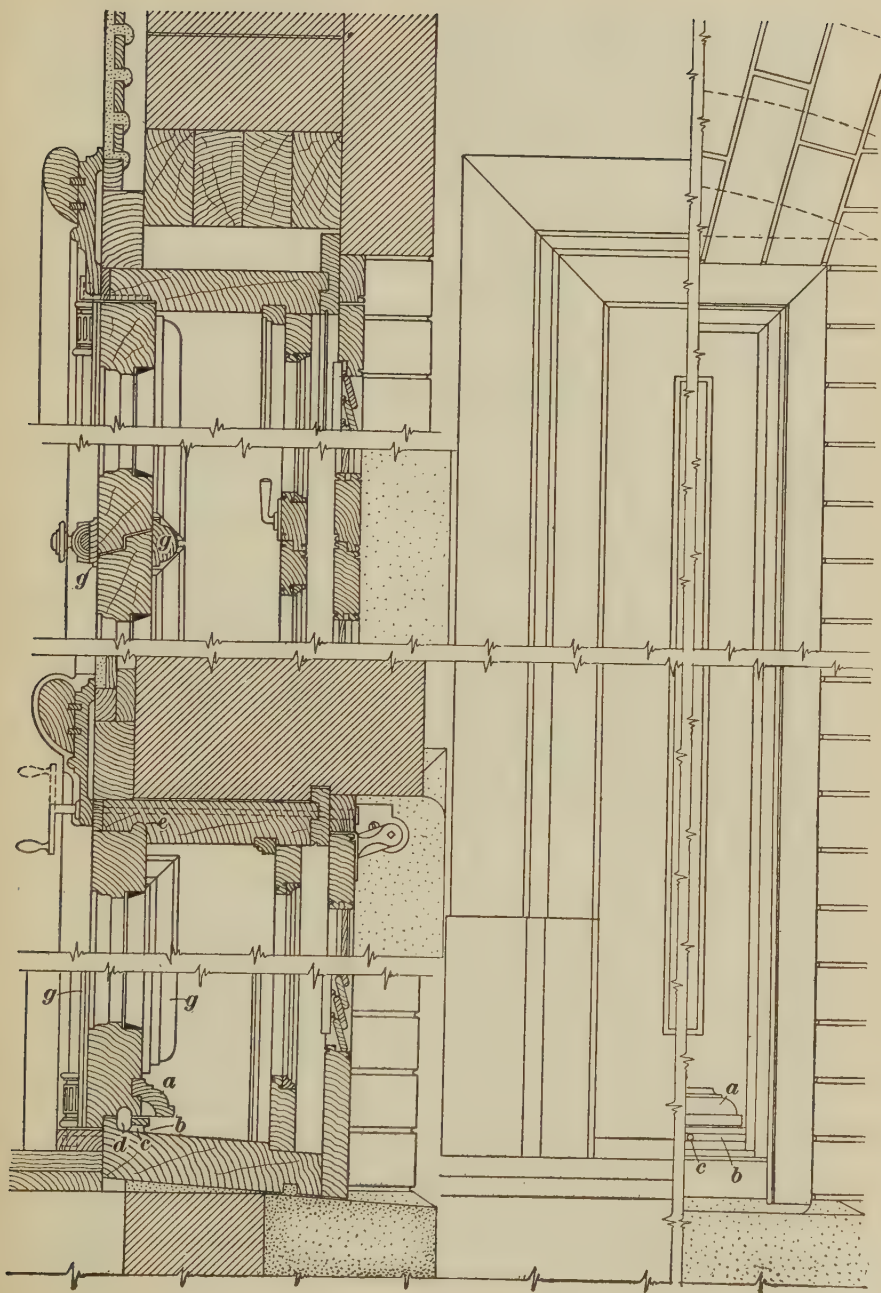


FIG. 31

The sash in casement windows should be made thicker than for double-hung sash, as there is more strain upon them because of their being hung on one side. For small casements $1\frac{3}{4}$ inches is a sufficient thickness and $2\frac{1}{2}$ inches or more for large sash.

In Figs. 30 and 31 outside mosquito screens are shown. They are made in two parts like the sash with vertical meeting stiles and cover the entire opening. Blinds can be used on these windows in addition to the mosquito screen if shutter workers are provided, as shown.

The student is not required to send in drawings of the windows shown in Figs. 30 and 31, but it will be excellent practice for him to make drawings of them, as such details are commonly required to be drawn in architects' offices. The beginner cannot, therefore, be too familiar with this class of drawing.

DOORS AND DOOR FRAMES

86. Outside Door and Frame in Masonry Wall.—In Fig. 32 is shown a detail drawing of a door and door frame in a masonry wall. The frame *a* in (a) is generally set when the building is nearly finished and is made somewhat smaller than the masonry opening. It is then blocked with rough lumber or studs *b* which are securely fastened to the wall and support the frame. The frame is double-rabbeted to take the main door on the inside and a screen door on the outside. The *staff bead* *c* forms a finish for the corner and should be fitted tightly against the masonry jambs to make a weather-tight joint. It is frequently made with a *quirk* *d*, which conceals the joint with the masonry. The inside trim, or *architrave*, is shown at *e*. A *transom sash*, which is a common feature over outside doors, is shown at *f*; the *transom bar* *g* forms the head of the door and the sill for the transom sash.

The door *h* is shown with heavily molded panels on the outside and with a lighter molding on the inside panels, which will correspond to the moldings of the interior doors. The outside moldings *i* are called *raised moldings*, as they project beyond the face of the door. The interior moldings *j* are

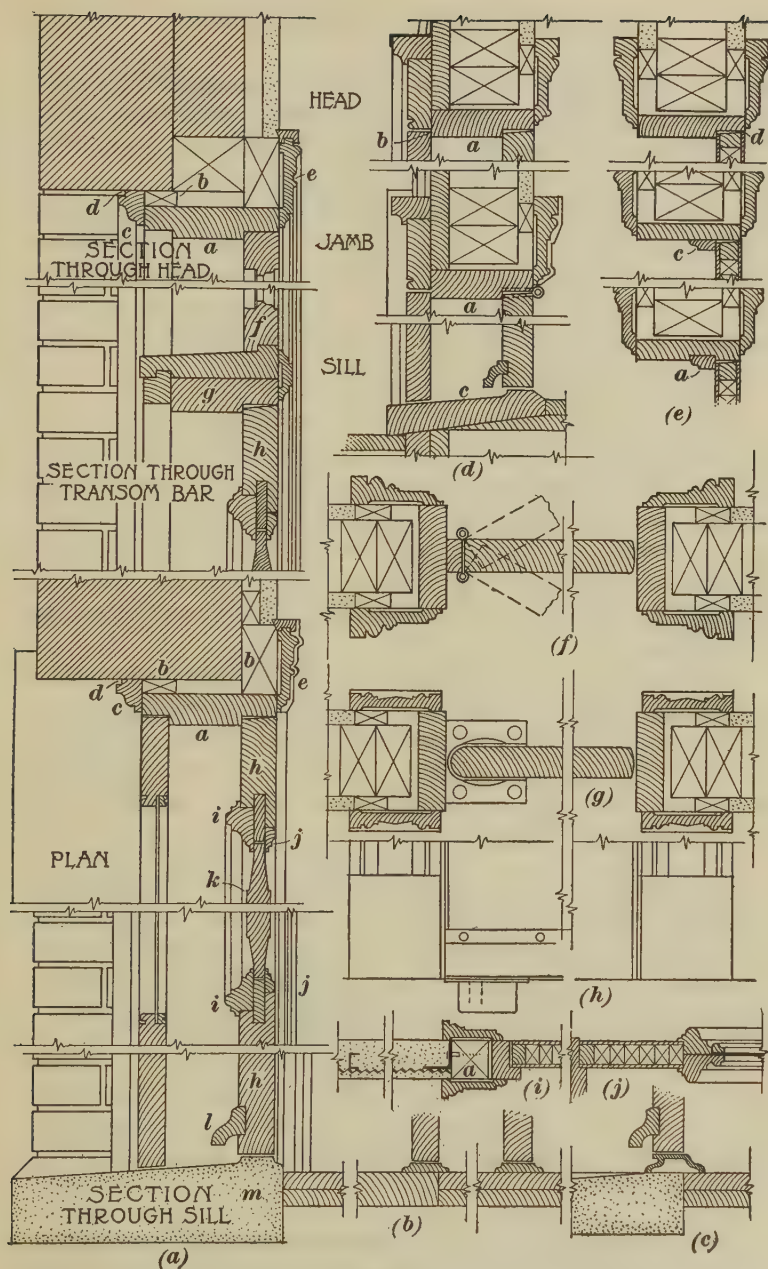


FIG. 32

called *flush moldings* because they do not project beyond the face of the door. The panel *k* is known as a *raised panel* on account of its having a raised face worked on it, whereas a *plain panel* is of uniform thickness throughout.

A drip mold *l* is set into the bottom rail of the door to protect the joint with the sill from wind and rain. The stone sill *m* has a *saddle* worked in it which projects above the floor level. Ordinary wooden saddles, or thresholds, used with interior doors and with exterior doors with wooden sills are shown in (*b*). A metal saddle is shown in (*c*).

87. Outside Door and Frame in Frame Wall.—In Fig. 32 (*d*) is shown a detail of an outside door and frame such as is used in a frame building. The frame *a* is rabbeted on the inner edge to receive the door and a rabbet is formed on the outer edge to receive a screen door by setting the outside architrave back from the face of the frame $\frac{1}{2}$ inch, as at *b*. The sill *c* is of wood and has a saddle worked on its inner edge.

In (*e*) are shown sections of frames for inside doors in 6-inch partitions. The stop *a* is let into the face of the jamb, and the stop *c* is nailed to the surface of the jamb, though it may be secured to the jamb by adjustable screws. At *d* the frame is shown with a rabbet worked in the jamb to take the door in the customary manner.

88. Double-Acting Doors.—In (*f*) is a double-acting door and frame. The door is hung on double-acting spring hinges. In (*g*) is shown a double-acting door operated by a double-acting spring floor hinge, which is let into the floor as shown in (*h*). At the top of the door a plain pivot is used.

89. Doors in 2-Inch Partition.—A method of trimming a door in a 2-inch solid plaster partition is detailed in (*i*). The buck, or rough frame, *a* is fastened to the angle-iron uprights of the partition, and the door frame is secured to the buck.

90. Doors With Glass Panels.—In (*j*) is detailed a section through the side rail of a door with a glass panel sur-

rounded by a raised molding. The molding is divided on one side of the door and the glass is held in position by nailing the small portion of the molding in place.

91. The student should make drawings of some or all of the details shown in Fig. 32, and thus obtain a good knowledge

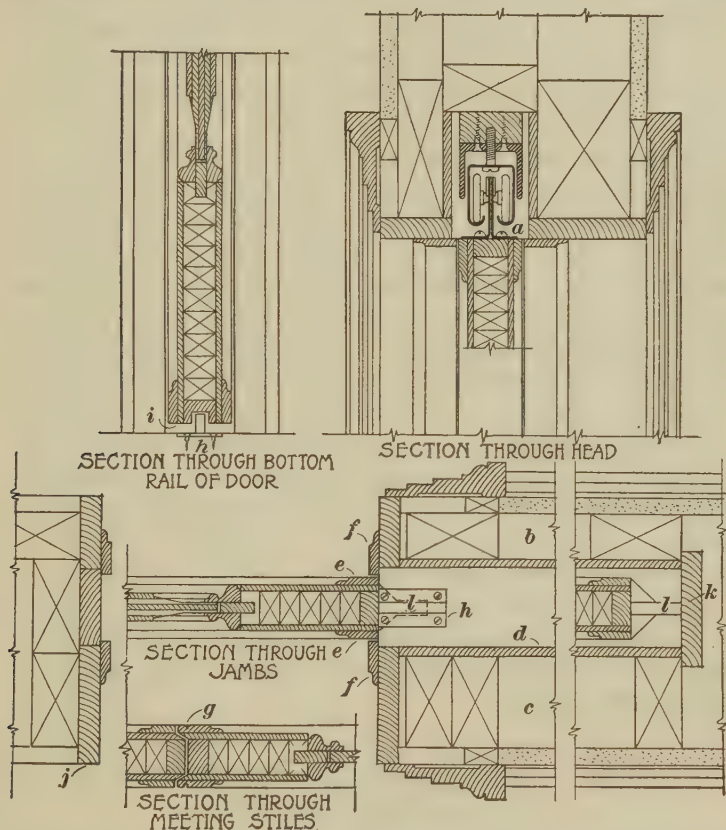


FIG. 33

of details and the methods of representing them. They should not, however, be sent to the Schools for correction.

92. **Sliding Doors.**—Sliding doors differ from ordinary doors chiefly in the method of hanging them. Generally, they are hung with overhead hangers which are secured to the top

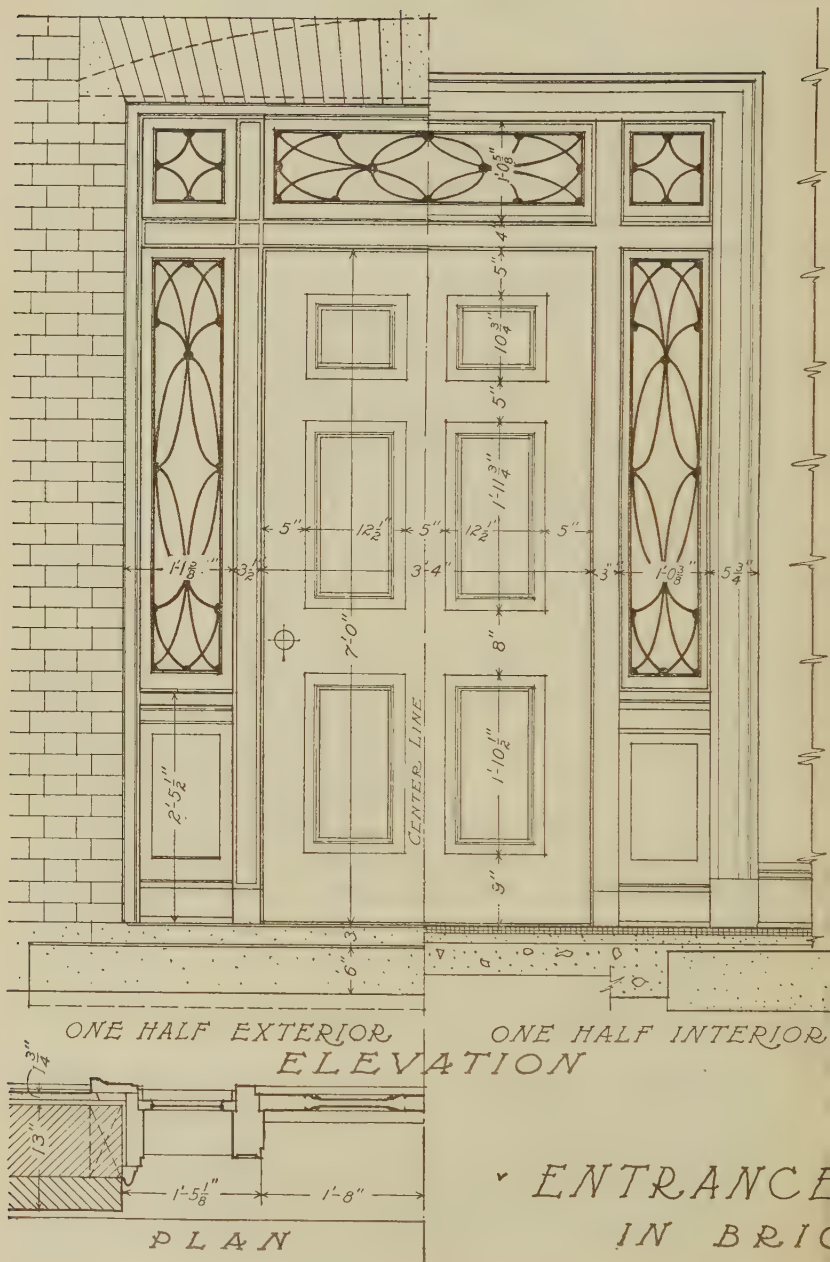
of the door and run on a single steel track. Sometimes they are hung on adjustable hangers, with roller or ball bearings, that run in tubular tracks, as shown at *a*, Fig. 33. Frame partitions for sliding doors are from 10 inches to 13 inches in thickness, depending on the thickness of the doors and the sizes of the studs. If the partition is not a bearing partition the studding at *b* and *c* may be 2 inches in thickness, as shown at *b*. If, however, the partition supports floorbeams or a partition above, the studding on one side of the partition is made 4 inches in thickness, as shown at *c*.

The *pockets*, into which the doors slide, should always be lined, as shown at *d*, so as to keep out dirt and plaster. They should also be provided with a back piece *k* against which the door may strike. The doors should be provided with *rubbing strips e*, which are applied to the four edges of the door on both sides, so that the door cannot rub against the stops. The *stops f* should be applied to the jambs and head and be adjustable. A special joint *g* is formed at the meeting stiles. The edge of one door is let into the edge of the other door so as to preserve the alinement of the doors when closed, and so that there shall be no opening between them. A cast-iron *guide h* is screwed to the floor just inside the pocket and works in a slot formed in the bottom edge *i* of the door. This keeps the doors from swinging sidewise.

Sliding doors are usually designed in pairs, but a single door may be made to slide in the same manner as double doors when the jamb on the side opposite a single pocket is made as shown at *j*.

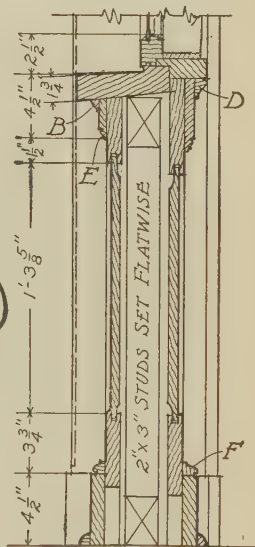
PLATE IV, TITLE: ENTRANCE DOORWAY IN A BRICK WALL

93. Exercise I.—Plate IV consists of one exercise, a detail of an entrance doorway in a brick wall. The border lines on the paper are to be arranged according to Plate I with one panel instead of four. At the left-hand side of the plate is an elevation of the door. One side shows a half elevation of the exterior, the other side a half elevation of the

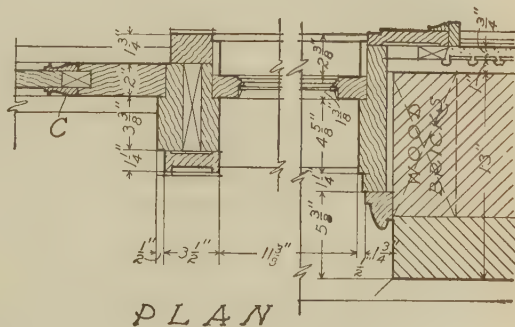




FOR ELEVATIONS, SECTION AND PLAN
ONE HALF INCH EQUALS ONE FOOT.
FOR DETAIL SECTIONS AND PLAN
ONE INCH EQUALS ONE FOOT.
PROFILES OF MOLDINGS FULL SIZE.



SECTION THRO'
WINDOW SILL



interior. In making details it is customary to draw out only as much as is necessary to show all the different parts of the feature that need to be shown. For instance, showing one-half of a symmetrical feature of a building is all that is necessary to give complete information. In the space required to show the entire outside of the doorway in Exercise I, Plate IV, one-half of the exterior and also one-half of the interior elevation can be shown.

A vertical section through the center line, or *axis*, of the doorway is drawn to the right of the elevation, and scale details of sections through various parts of the doorway are given on the right side of the plate. A drawing, or detail, as it is more generally called, such as this, gives the contractor complete information regarding what is required in the form and arrangement of parts of the doorway. This is the whole object or function of any detail. The best detail is the one that gives in a clear and complete form all the necessary information regarding the part detailed. The best detail also makes it unnecessary for the contractor to ask questions of the architect as to the meaning of this or that part of the drawing, or to request further drawings of the same subject.

94. The student has undoubtedly gained, from his work on the previous plates, a knowledge of how to set his work out on the plate. The drawing as given in Exercise I is shown at a scale of $\frac{1}{2}$ inch to a foot, 1 inch to the foot, and full size. The plate, as drawn by the student, will be at the $\frac{3}{4}$ -inch and $1\frac{1}{2}$ -inch scales, and full size. In drawing the elevations, plan, and section, measurements are to be made from the illustration at the $\frac{1}{2}$ -inch scale and laid out on the plate at $\frac{3}{4}$ -inch scale. The large details at 1-inch scale are to be measured off at that scale, and laid off on the plate at the scale of $1\frac{1}{2}$ inches to the foot. The full-size profiles of the moldings A, B, C, D, E, and F will be drawn at the same size as shown on the plate.

95. Freehand Work.—In this exercise the use of freehand drawing is shown. The lead work in the ornamental

glass on each side of the door and in the transom sash is generally drawn freehand, as are also the full-size and other moldings on the drawing.

In drawing one of the side lights, first lay out the axes, or center lines, ab and cd , in Fig. 34, bisecting the rectangle in both directions. Lay off the points e and f , using the scale.

Next lay off the curves ei , gi , and ea . The process of completing the pattern by transferring will next be described.

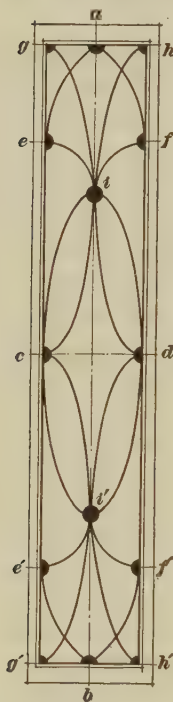


FIG. 34

96. Transferring.—After drawing the three curves so that they appear to be satisfactory, take a piece of tracing paper and hold it over the upper part of the rectangle, and trace the three lines through in lead pencil. Also draw the lines gh and the upper part of the axis ab . Then take up the paper and reverse it, placing it with the lead-pencil lines against the paper on which the drawing is being made, so that the axis line will coincide with the axis line on the drawing and the points g and e will be over the points h and f . Mark over the backs of the three curved lines with the pencil, pressing firmly so as to press some of the lead off onto the drawing. Take up the piece of paper and the lines af , hi , and fi will appear faintly on the drawing but in the correct positions. These lines can then be strengthened with the lead pencil.

There will now be lines on both sides of the piece of paper and by reversing properly the lines $e'i'$, $g'i'$, $h'i'$, etc., can be transferred and afterwards drawn in firmly. By this process these symmetrical lines can be drawn with great accuracy. The remaining lines ci , $c'i'$, etc., can be drawn in a similar manner. The side light on the other side of the door can be transferred, using the same pieces of paper, and both side lights will be of exactly the same design. This

method of transferring should be diligently practiced, as it is frequently used in the offices of the best architects.

97. Making the full-size moldings will be excellent practice in the use of freehand drawing. As a method of practice in making these molding it is recommended that a piece of tracing paper be held over the moldings shown in the exercise, and the drawing of the curves in these moldings practiced. After control of the hand has been obtained, moldings can be drawn in on the exercise. They should be drawn in with faint or light lines with a soft pencil, such as a BB or B, so that they can be erased if not successful. When the molding is satisfactorily drawn, it may be drawn in firmly.

98. After this exercise has been carefully studied and all of its parts completed, a fresh sheet of tracing paper should be tacked down on it and a clean, neat tracing made of it in pencil, which is to be sent to the Schools for correction. Careful attention should be paid to the lettering of this exercise so that the lettering will add to the attractive appearance of the drawing.

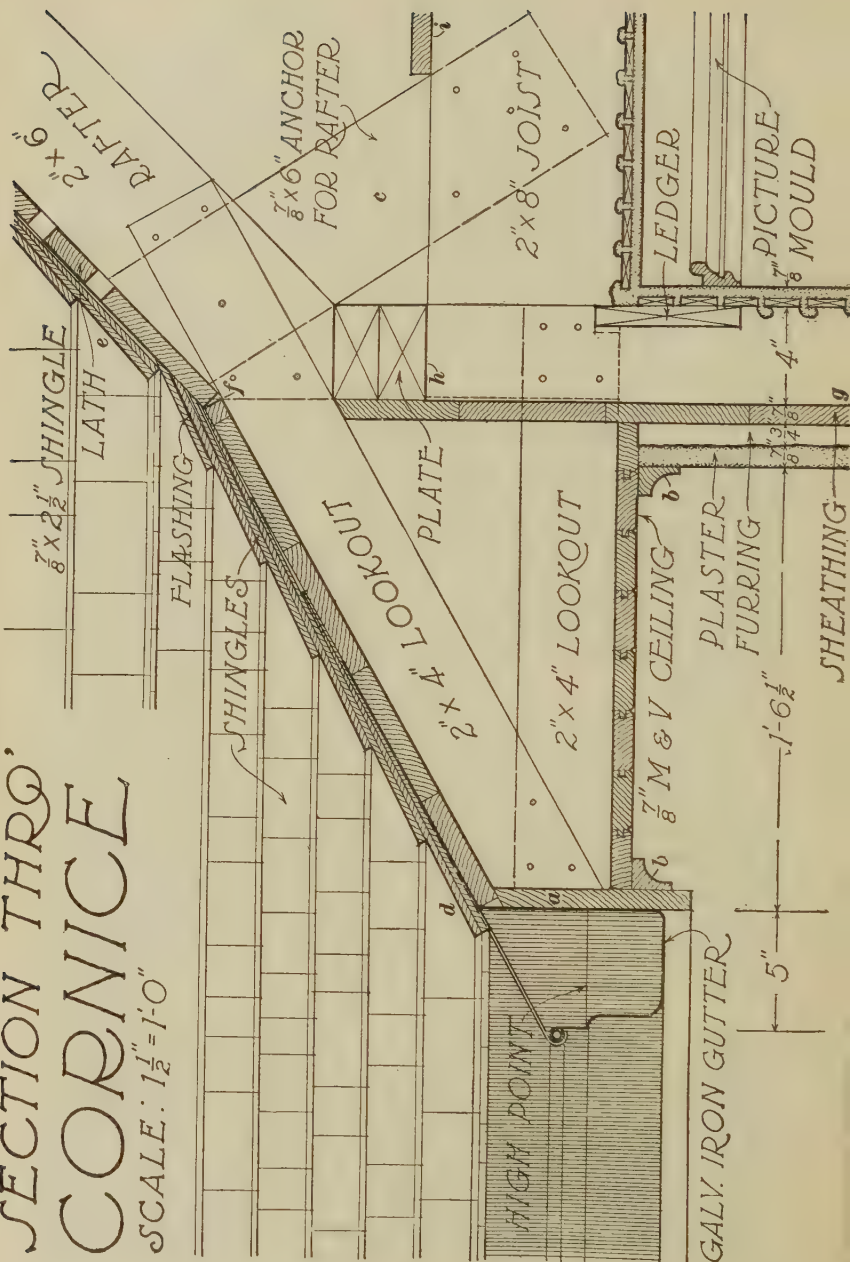
PLATE V, TITLE: DETAILS OF CORNICES

99. Plate V will consist of two exercises showing different types of cornices and gutters. These exercises are given at $1\frac{1}{2}$ -inch scale and are to be drawn on the plate at the same scale. The plate is to be laid out as in Plate I, which is to be divided into two panels. The size of each panel will be $6\frac{1}{2}$ in. $\times$ $9\frac{3}{4}$ in. Exercise I is to be drawn in the center of the upper panel and Exercise II in the lower panel.

100. Exercise I is a simple box cornice with a sheet-metal gutter. A frame wall consisting of 4-inch studs is shown with a ledger board and a plate. The ledger board supports the attic or top-floor joists and the plate carries the rafters. The cornice is supported on *lookouts*, which are short lengths of $2'' \times 4''$ studs nailed to the rafters, to the studs, and to each other. Boarding is nailed on the upper lookouts to receive the shingles, and ceiling boards are nailed to the lower look-

SECTION THRO' CORNICE

SCALE: $1\frac{1}{2}" = 1'-0"$



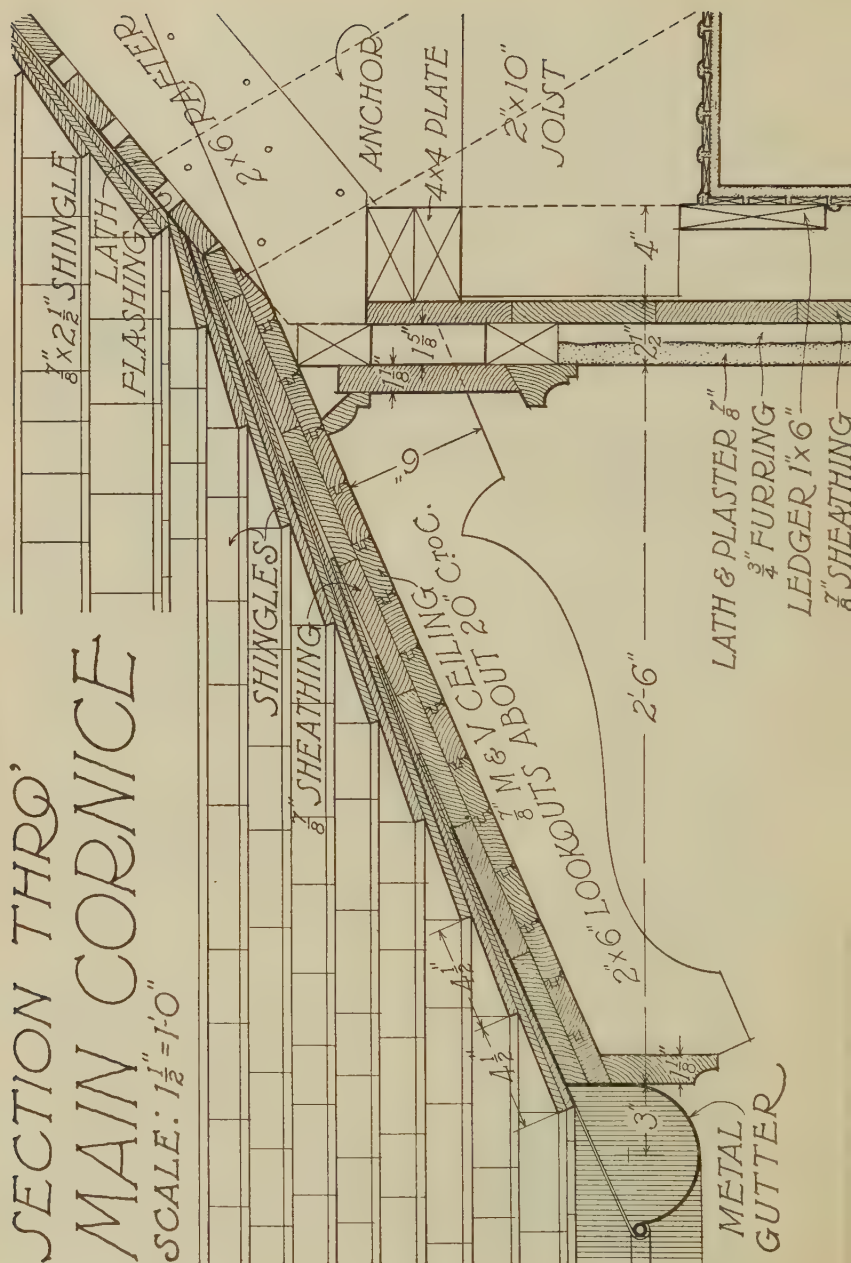
outs to form a soffit, which will be seen and will affect the appearance of the building. A fascia *a* is nailed to the outer ends of the lookouts against which the metal gutter is placed. Moldings *b* are placed in the corners to make a neat finish. The plank *c* is used to anchor the rafters to the floor joists so that they shall not slip off the plate.

In starting to draw this exercise, draw first the wall studs, then the plate, attic joists, ledger, rafters, rafter anchors, and the lookouts. Draw these lines in lightly, measuring from the outside face of the studs and the top line of the joists. Next lay out the roof boards, the sheathing, the fascia *a*, and the ceiling boards, then the shingles, starting with two thicknesses of shingles at *d* and *e*. The lathing and plastering may be done next, and then the gutter. The elevation may then be drawn, and the indications of materials put in. All this work should be put in with light lines until all the lines are drawn. The whole drawing can then be finished by putting in the lines firmly and of different thicknesses, as shown in the cut. Letter the exercise carefully, imitating the form of letters shown. Be careful to show the flashing where the slope of the roof changes, also the sheet metal of the gutter which extends up under the shingles. Care should be exercised in laying out the shingles, remembering that a common shingle is about $\frac{1}{2}$ inch thick at the butt and about $\frac{1}{16}$ inch at the top. The length of the shingles shown in this exercise is 16 inches. The lowest, or starting, course of shingles is always doubled.

101. Exercise II.—The same general method of procedure as was given for Exercise I may be followed in Exercise II. A new feature in this exercise is the use of freehand drawing in forming the curved profiles of the lookouts. These lookouts are exposed and affect the appearance of the building, therefore it is desirable that the outline of the brackets shall have a pleasing form. Put a piece of tracing paper over the drawing where the bracket is to be shown and practice making the curves freehand until confidence is developed, and then draw the line in on the plate. If this or any of the

SECTION THRO'
MAIN CORNICE

SCALE: $1\frac{1}{2}'' = 1'-0''$



drawings do not look clean and neat when first drawn, another piece of tracing paper or cloth should be tacked over it and a neat clean tracing of it made.

102. As one exercise is to be drawn at a time, the lower panel of the plate should be protected while the first exercise is being done. After the plate is completed in pencil on paper it is to be carefully traced on tracing cloth with ink. This work will familiarize one with the customary method of preparing drawings. These drawings should be carefully studied while they are being drawn. It should never be forgotten that the drawings given are not merely lines but they show the arrangement of various materials to form parts of buildings in such a way that architects, builders, and mechanics can understand them.

PRACTICE WORK

103. In the following pages are given a number of illustrations showing various important details of buildings. The beginner in architectural drawing will find it profitable to study these drawings carefully, and, as an additional means of self-development, it is recommended that he practice drawing as many of them as possible.

CORNICES

104. Fig. 35 shows a sunk gutter, also details at a larger scale of some of the moldings that are to be used in cornice construction. This cornice is of a classic or colonial design and has a crown molding *A* and a dentil course *a*.

105. In Fig. 36 is a classic cornice fitted against a brick wall. The plate is anchored down to the wall by long bolts having plates of metal on the bottom and nuts and washers on the top where the bolts project through the top of the wooden plate. Wood bricks *a* in the section and *b* in the elevation are built into the wall at frequent intervals and the cornice blocking *e* is nailed to them. The lookouts extend

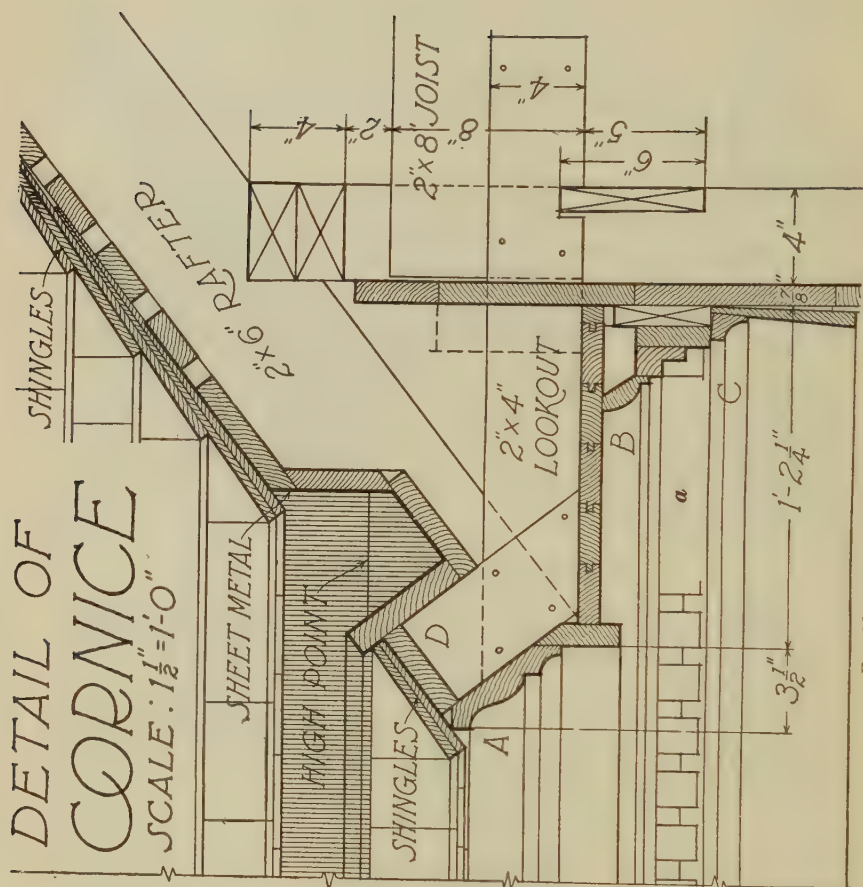
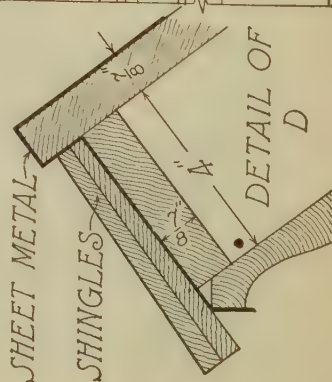
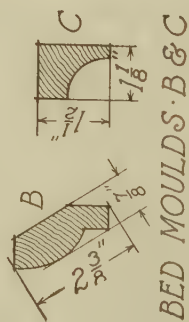
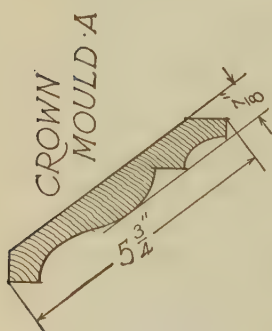


FIG. 35

DETAIL OF BOX CORNICE

SCALE: $1\frac{1}{2}''=1'-0''$

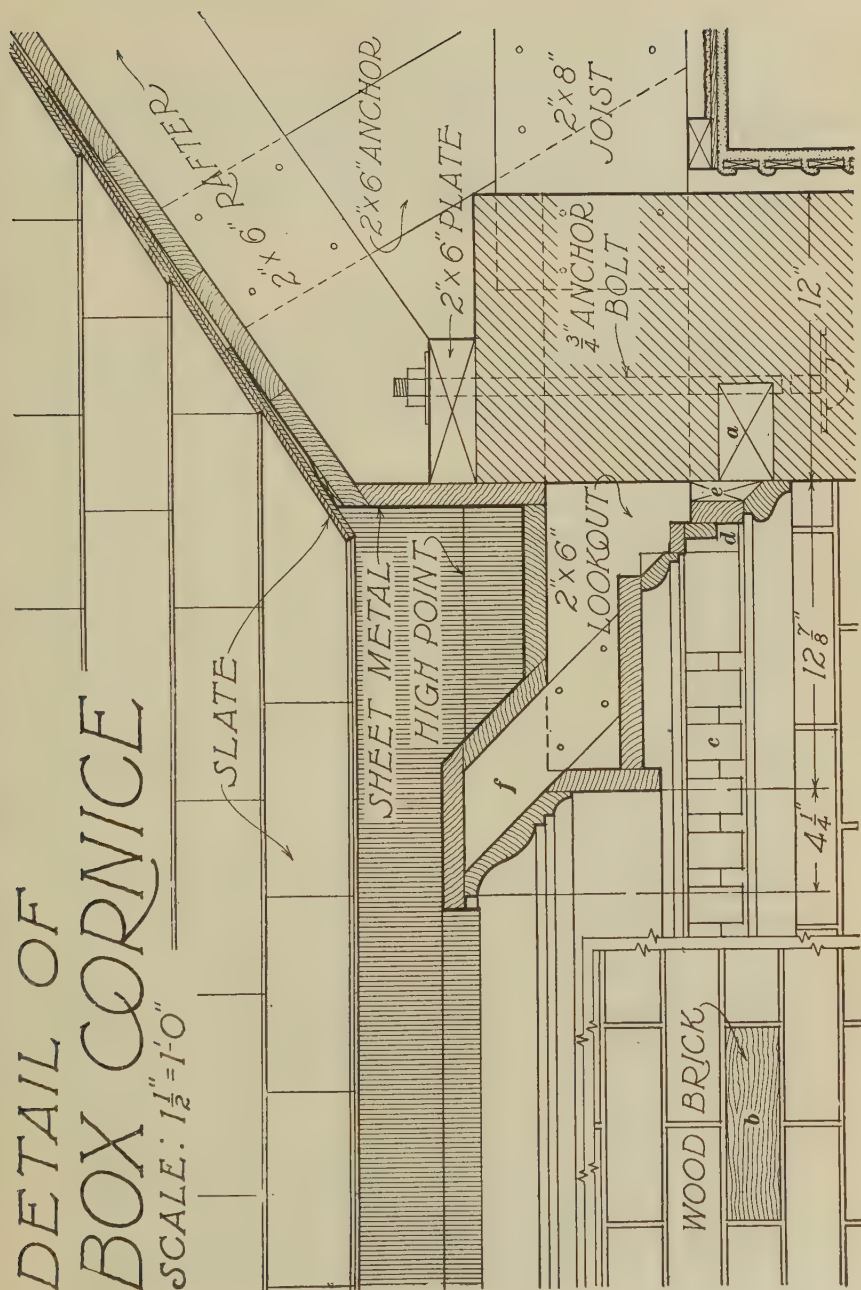


FIG. 36

through the wall and are nailed to the attic joists when possible. At *c* dentils are shown in elevation and at *d* in section. The block *f* is securely nailed to the lookout and supports the crown mold and front of the cornice. The first row of slates is doubled, shorter slates being used beneath as shown.

PORCHES

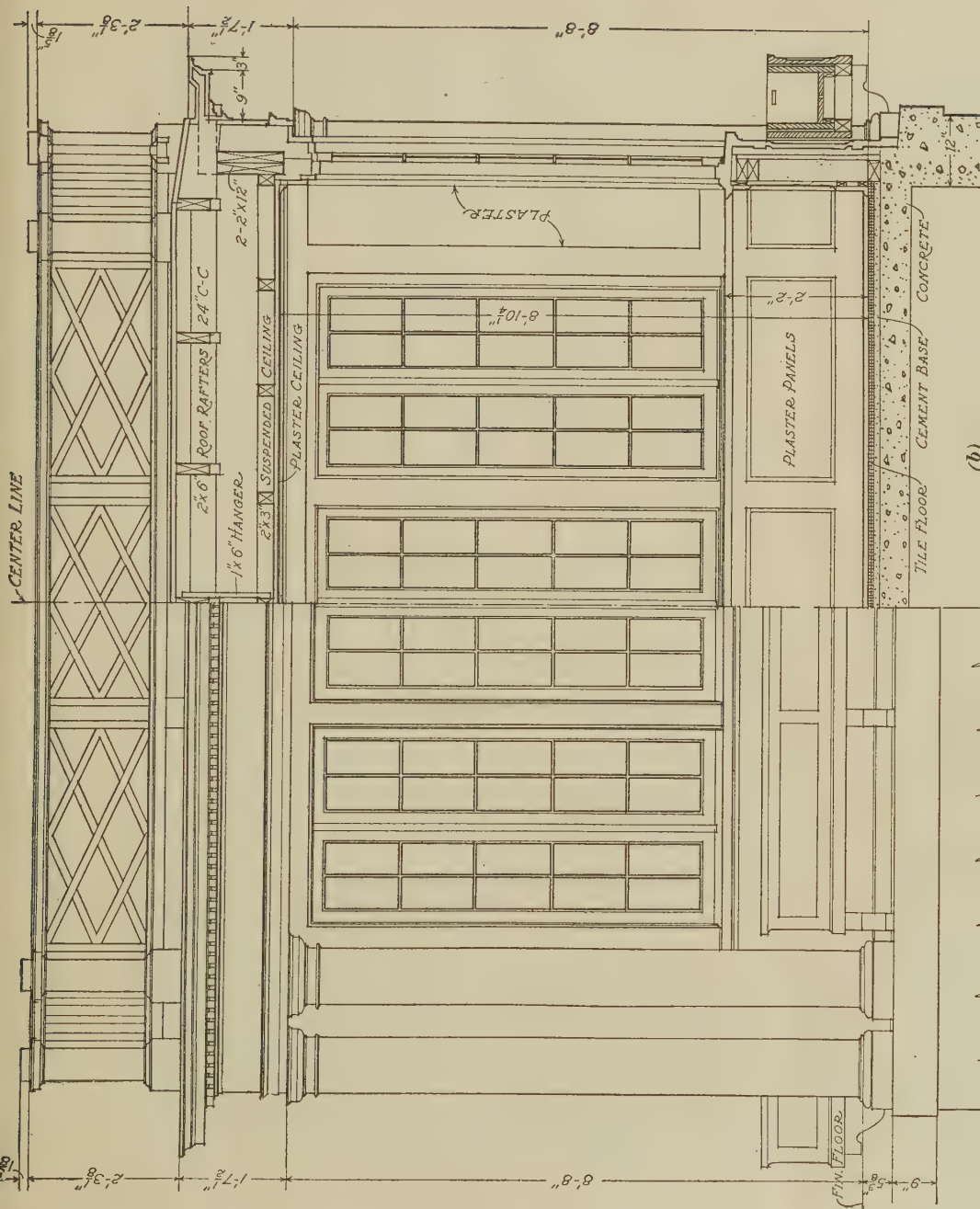
106. Description.—A characteristic feature of American dwellings is the porch, which occurs on almost all residences. Porches form sheltered places in which to sit in warm weather. They may be enclosed with sash containing glass so as to form what are known as *sun rooms*, which are used for sitting rooms in cold weather, for breakfast rooms or sleeping rooms, etc. In some cases fireplaces are built in them and they are frequently heated by steam or hot-water radiators so that they are comfortable in the coldest weather.

The sun room may be transformed into an open porch by removing the sash. The term *porch* is applied also to small shelters over entrance doorways which are for the purpose of giving temporary shelter while the door is being opened, such as the service porch in the blueprint entitled First-Floor Plan.

The essential parts of a porch are the floor, which is generally placed above the ground, the roof which covers the porch space, and the columns or piers which support the roof. A railing is provided around the porch when the floor is more than 2 or 3 feet above the ground, and also around the roof in some cases. Steps are provided from the ground to the floor of the porch. There is a great variety in the designs and forms of these various parts, as will be seen by walking through a suburban town and inspecting the different houses.

107. In Fig. 37 is illustrated a porch which is fitted up as a breakfast room and which possesses all the characteristic features of a porch of the enclosed type. In (*a*) is shown an elevation of one-half of the outside of one side of the porch. This half elevation shows all that is necessary to be shown of

CENTER LINE



(b)

this elevation, and it is not customary to show the other half in a case like this. A half elevation of the inside of the same wall is shown at (b) instead of the other half of the exterior. This half elevation supplies all the information necessary regarding the interior arrangement of the parts. In connection with this interior elevation a section is shown which gives information about the construction. The half plans (c) and (d) complete the series, and these drawings together generally suffice to show everything necessary except full-size details of moldings and profiles.

It is not required to make a drawing of this porch, but it is desirable that the drawing be studied very carefully so as to understand every line and to master thoroughly the construction of the porch. In studying the drawing, use the scale and measure off the various parts of which the porch is composed; also, note the construction.

108. The porch shown in the figure has a tile floor. The concrete walls supporting the walls of the porch enclose a mass of earth upon which a concrete floor is laid. Upon this is placed a tile floor consisting of 9"×9" quarry tile. The upper walls are formed of studs covered on the inside with plaster and on the outside with wooden pilasters, panels, etc., and surmounted by a cornice. The roof beams slant and support the roof boarding, upon which a tin or copper roofing is laid. The sheet metal is carried down into the gutter and out over the edge of the cornice. The ceiling of the porch is hung or suspended from the roof beams by means of 1"×6" hangers and 2"×3" studs, and a plaster ceiling is applied to the studs.

Casement windows on three sides of the porch open outwards, thus preventing the entrance of rainwater. By opening outwards they neither extend into the porch nor occupy useful space. Flower boxes, lined with sheet metal and provided with drains, are attached to the outside of the porch on two sides and are supported on brackets. The tops of the flower boxes are kept some distance below the window openings so that the plants will not be injured when the sash are

opened. Provision is made for mosquito screens which must cover the entire opening, and consequently should consist of two screens hinged at the sides and opening into the room.

109. Scale Details of Porch.—In Fig. 38 are shown details of the porch on a larger scale. At this scale all details of shape and construction should be clearly shown so that only a few details at full size need be shown to give all the information needed to construct the porch.

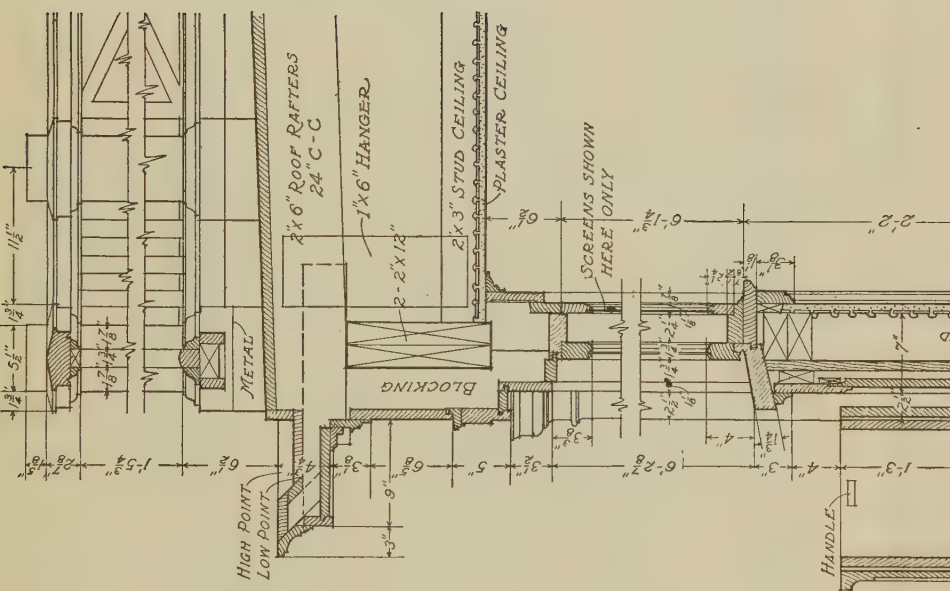
CHIMNEYS AND FIREPLACES

110. Details of Construction.—The design of chimneys and fireplaces is one of the most difficult problems that the draftsman has to solve. It is, therefore, necessary that he shall have a good knowledge of their construction and functions which are described in the paper on *Common Brickwork*.

An example of a properly constructed chimney and fireplace as it would appear in a good drawing is shown in Fig. 39. The projection of the chimney into the room is called the *chimney breast*. The height of a fireplace should be about 2 feet 6 inches to 2 feet 8 inches above the finished floor, its depth from 16 inches to 24 inches, and its width from 2 feet to 5 feet. A properly designed fireplace should have sloping sides, as shown at *a*, with a slope of about 3 inches in 1 foot, as well as a sloping back *b* so as to reflect the heat into the room.

The back *b* should slope forwards and form the *throat c*, which should be from $2\frac{1}{2}$ inches to 4 inches in depth, and of the same width as the fireplace opening. The total area of the throat should be not less than that of the flue lining. The throat should be at least 2 inches or 3 inches above the top of the opening of the fireplace, as shown at *s*, and as near the front of the fireplace as possible.

The *smoke shelf e* is an important feature. It prevents the air from rushing down and forcing smoke into the room when the fire is started.



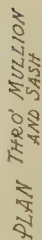
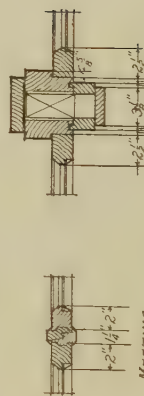
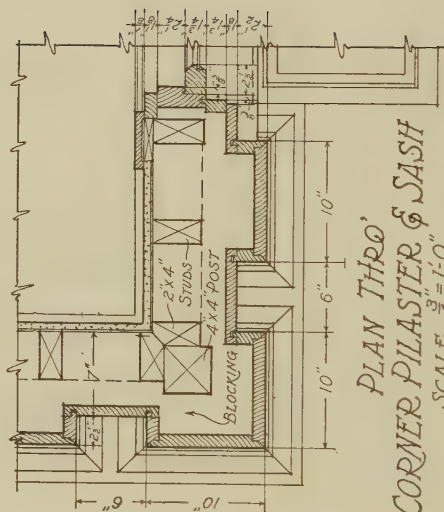
SECTION THRO' BREAKFAST PORCH

SCALE $\frac{3}{4}'' = 1'-0''$



PLAN THRO'
CORNER PILASTER & SASH

SCALE $\frac{3}{4}" = 1'-0"$



The *smoke chamber* *f* is formed by drawing the brickwork together at an angle of 60° on the sides, until it is reduced to the dimensions of the flue lining. The *lining* *l* is then started, being supported by the brickwork, as shown.

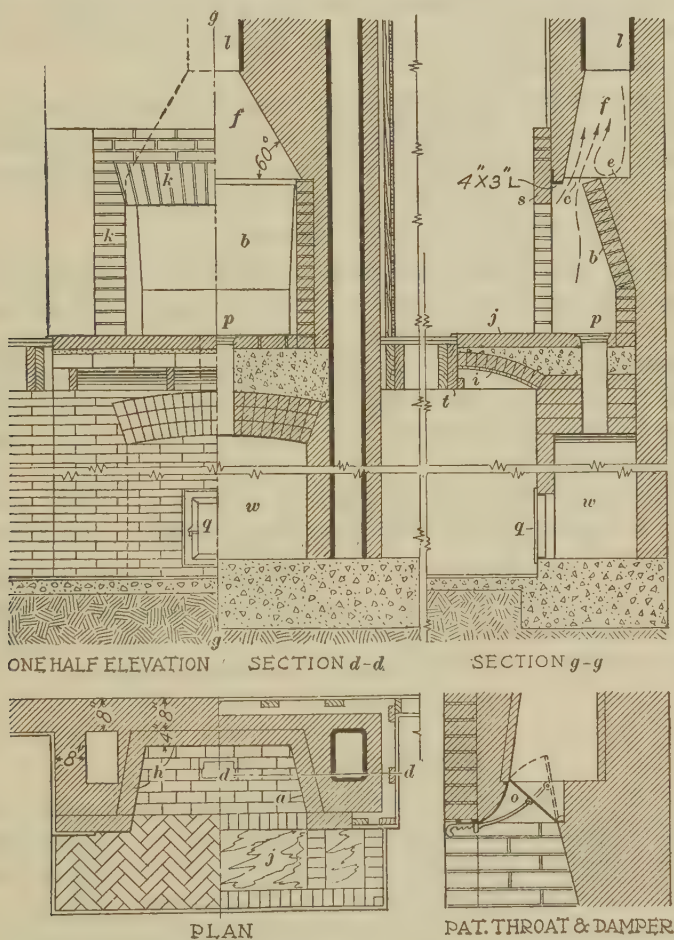


FIG. 39

The *hearth* *j* is extended in front of the fireplace so as to catch embers that may fall out of the fire. It is supported on the *trimmer arch* *i* consisting of a single rowlock arch about

20 inches wide, springing from the chimney to the *header t*. This arch is laid upon a wooden center, which is left permanently in place to receive the lath and plaster of the ceiling. Upon the trimmer arch, the hearth is built of cement or concrete and is finished in tile, marble, or brick. The hearth should extend at least 12 inches on each side of the fire-place opening.

Patent throats and dampers o are used in good work and are made of cast iron with a properly shaped throat and a hinged damper which can be adjusted to regulate the draft as desired. These devices serve at the same time as supports for the brick-work of the front of the smoke chamber.

111. Finish of Fireplaces.—Firebrick, soapstone, and metal are used for the back and sides, or lining, *h* of the fire-place. Firebrick forms a most efficient non-conductor and, when laid up neatly, forms an excellent lining. Cast-iron linings are made in ornamental patterns, which are used where it is intended to use grates. These linings should be backed up with firebrick.

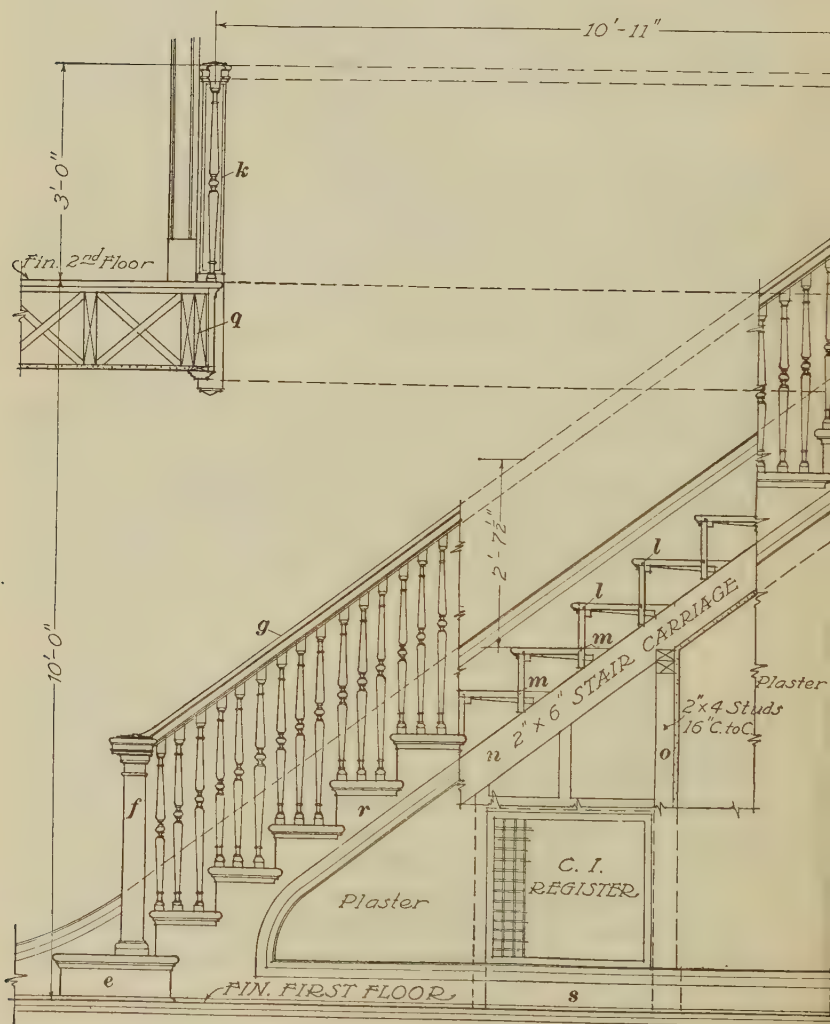
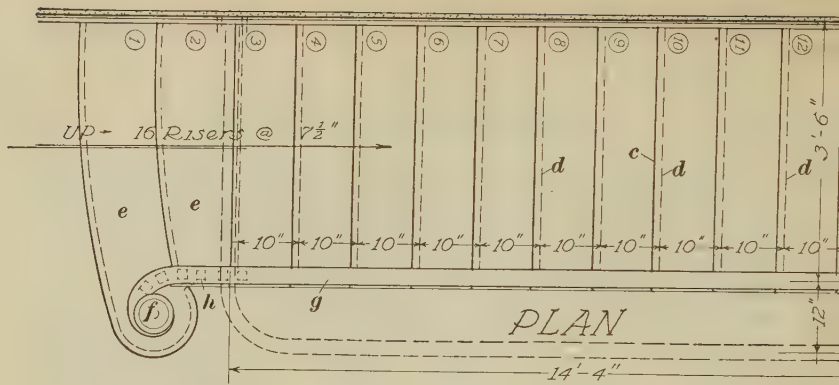
The *facings k* of a fireplace may be formed with brick, marble, or tiles, and the hearth should be finished to correspond.

112. Ash-Trap.—At *p* an ash-trap is shown opening into a chute that leads to an ash-pit *w* formed in the body of the chimney in the cellar. This pit is furnished with a clean-out door *q* through which the ashes are removed.

INTERIOR DETAILS

113. Stairs.—The design of stairs requires a great deal of skill, and too much study cannot be put on this subject. In Fig. 40 is a detail of the stair case used in the eight-room residence which will be drawn while studying *Architectural Drawing*, Part 2. In the plan the plastering of the wall is shown dotted at *a*. The two lines *b* inside the plaster represent the molded upper edge of the wall string.

The steps are shown by two lines, one of which is broken. The solid lines *c* represent the extreme projection of the



WEST ELEVATION

Architectural drawing of a porch structure, showing a section and elevation. The drawing includes dimensions and labels for various components.

Dimensions shown:

- 10"
- 3'-6"
- 3'-6"

Labels and notes:

- a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l*, *m*, *n*, *o*, *p*, *q*, *r*, *s*, *t*, *u*, *v*, *w*, *x*, *y*, *z*
- 2" x 12" Joists 16" C. to C.

Partial text at the bottom left: "d Panel" and "OOR".

Architectural drawing of a porch structure, showing a section and elevation. The drawing includes dimensions and labels for various components.

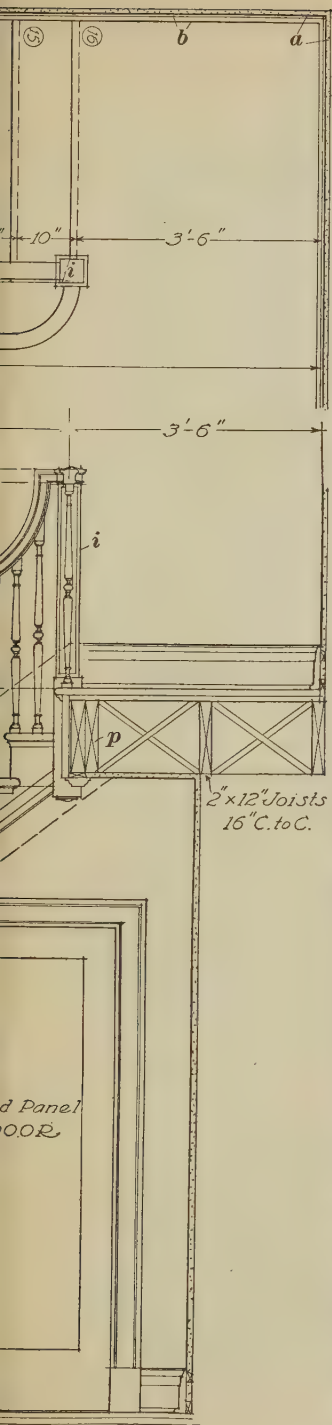
Dimensions shown:

- 10"
- 3'-6"
- 3'-6"

Labels and notes:

- a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l*, *m*, *n*, *o*, *p*, *q*, *r*, *s*, *t*, *u*, *v*, *w*, *x*, *y*, *z*
- 2" x 12" Joists 16" C. to C.

Partial text at the bottom left: "d Panel" and "OOR".



nosing of the step, and the broken lines *d* show the faces of the risers. The risers are numbered from 1 to 16. The bottom treads *e* have curved outlines. A newel *f* is shown standing on the curved end of the lower step, and the hand rail *g* is shown curving into it. A few of the balusters *h* are shown by dotted lines. The hand rail runs to a newel *i* situated over the sixteenth riser. From this newel the railing *j* continues on the second floor until it strikes a half newel *k* against the wall, as shown in the West Elevation. The side, or West, Elevation of the stairs shows various details of the stair, including the construction of the steps. The risers are tongued into the treads as at *l*, and the treads into the risers as at *m*. The portion inside the broken line is cut away and part of the stairs is shown in section. The carriages *n* are the rough timber supports that are put under the steps to give them stiffness.

In this section is seen the partition *o* of the toilet-room beneath the stairs. At *p* is shown the trimmer beam at the top of the stairs, together with the framing of the platform. At *q* is the trimmer at the other end of the stair opening. Both of these trimmers are doubled as shown.

The outside string *r* is shown curving down and mitering into the base *s*. At *t* is the header which extends between the trimmers and forms the side of the opening. This drawing will give a good model to work with in laying out the scale details of a stairway.

The learner is advised to make a detail like this for the sake of practice, but he is not required to send it in for correction.

114. There is only one way to learn how to draw and that is to practice continually. While the student is required to send in only a few of the plates and drawings given, he will serve his own interests best by making all the drawings shown. He should never forget while making them, that he is drawing *ideas* and not merely *lines*; that his drawings are to convey ideas clearly to other minds, and not merely to satisfy his own mind.

115. General.—For ordinary buildings it is not customary to make special detail drawings for the base, door, and window trim, moldings, doors, etc. It is more economical to buy such materials from woodworking mills that manufacture them in standard or stock designs. These designs are shown in catalogs that are issued by some of the larger mills. Examples of these standard designs are given in one of the Sections on *Carpentry*.

116. In more elaborate houses in which the architect wishes to have special trim, base, and other moldings it is necessary for him to furnish details showing his requirements. Examples of such details will be given in this discussion as well as in Part 2 of *Architectural Drawing*. The student should practice drawing out such details, following the models given. He will thus improve himself as a draftsman and increase his knowledge of the methods of presenting ideas by the use of lines.

KITCHEN DRESSER

117. Details.—A detail of a kitchen dresser is shown in Fig. 41. This dresser is shown in the kitchen in the first-floor plan of the building shown in the blueprints that accompany this Section.

In this figure are shown a front elevation, a plan, a side elevation, a section, and several sections of portions of the dresser at a larger scale. The essential parts of a dresser are closed cupboards above, with shelves and doors. These doors may be swinging doors as shown, or doors sliding on the bottom edge, which are less desirable. Under the cupboards is a counter shelf with a space above it about 18 inches in height. This counter shelf is generally made from 20 inches to 24 inches in width, and is used as a sort of table or counter. Beneath the counter shelf are drawers and cupboards. The left half in the dresser shown is fitted with drawers of different sizes and the right half is arranged as a cupboard with a shelf.

The elevation has been liberally marked with figures so that no difficulty may be experienced in making a drawing

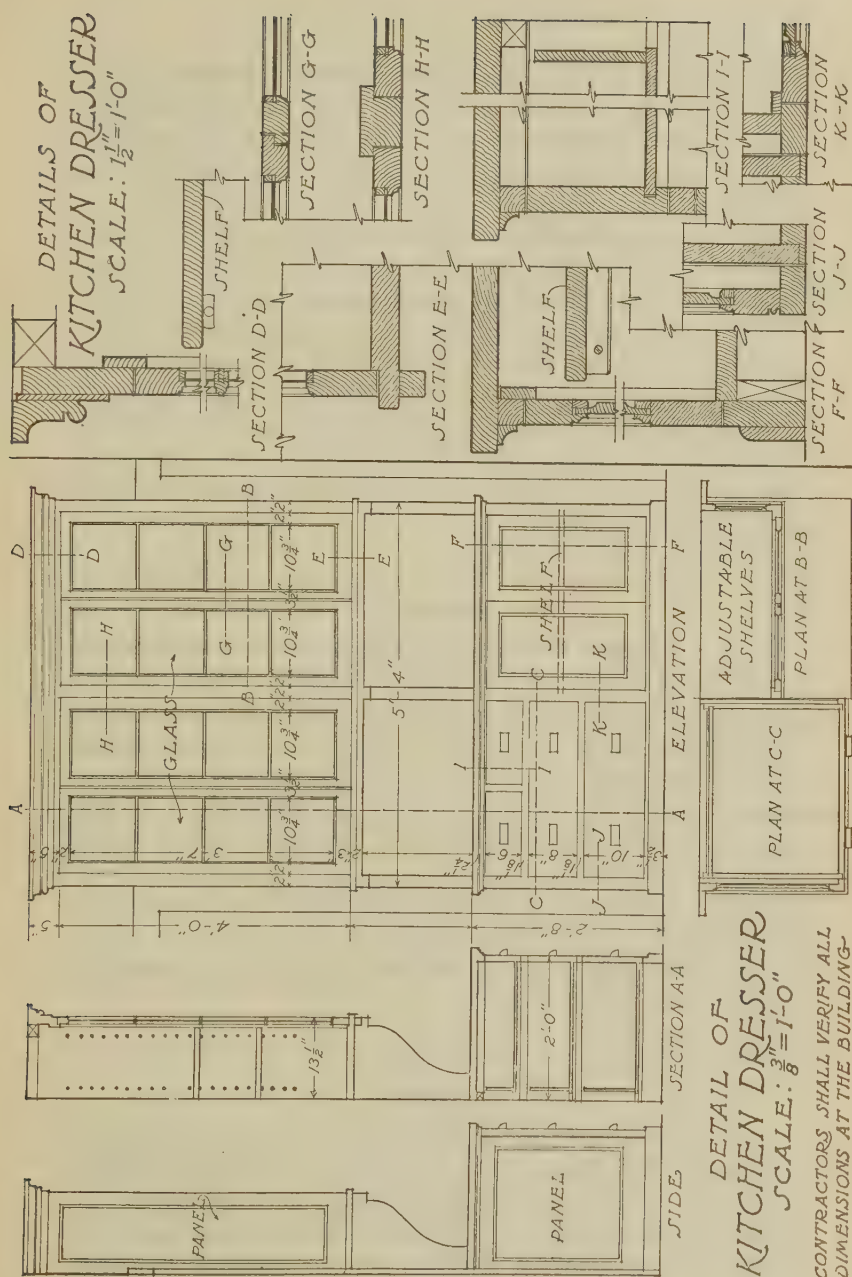


FIG. 41

DETAIL OF
KITCHEN DRESSER
SCALE: $\frac{3}{8}"=1'-0"$

CONTRACTORS SHALL VERIFY ALL
DIMENSIONS AT THE BUILDING-

of it if desired. While drawing the elevation the other drawings should be observed, especially those on the right-hand side, as these details will give information as to the character of the moldings and the methods of construction of the various parts.

The side elevation shows the paneled sides and the curved bracket which supports the upper cupboard. There are three of these brackets, which are shown on the front view.

The section shows a cut through the entire dresser on the line A A. The cut is made through the drawers below the counter shelf and shows the full width of the counter shelf. It also shows the shelves in the cupboard above and the holes which receive the pins upon which the shelves rest. By placing the pins in the holes above or below, the height of the shelves can be adjusted.

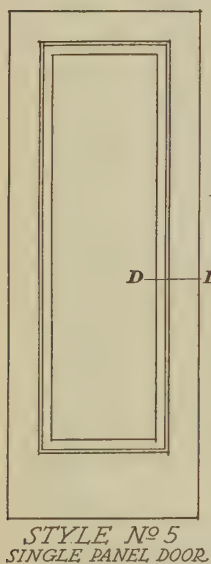
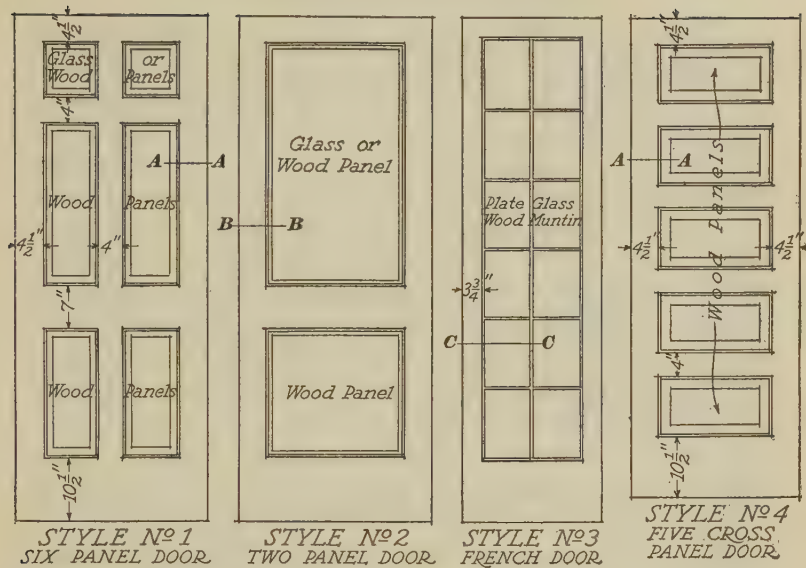
DOORS

118. Kinds of Doors.—Where there are several different styles of doors in one building, a sheet of doors is sometimes made. A door schedule is given in Fig. 42, which shows six different styles of doors together with sections through the various parts. In style No. 1 is shown a typical six-panel door in which the panels are separated by a vertical stile as well as by horizontal rails. The sizes of these panels may vary considerably according to the taste of the designer. Style No. 2 is a two-panel door of dignified appearance. The upper panel may be of glass or wood. A careful study of this sheet of doors will be profitable and enable one to draw such a detail when called upon.

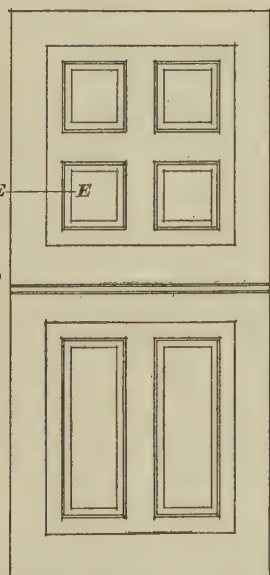
TRIM

119. The finish of doors and windows is called *trim*, *casings*, or *architraves*. The simplest form of casing consists of a board 4 inches or 5 inches in width mitered around the opening. The finish of doors and windows is capable of very elaborate treatment in which columns, pilasters, cornices

DOOR SCHEDULE



Scale $\frac{3}{8}$ " = 1'-0"



Scale $\frac{3}{8}$ " = 1'-0"

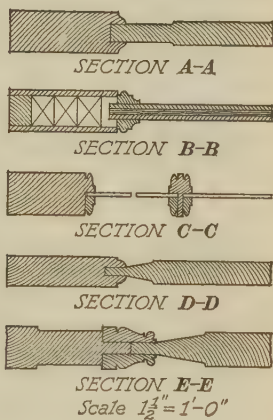


FIG. 42

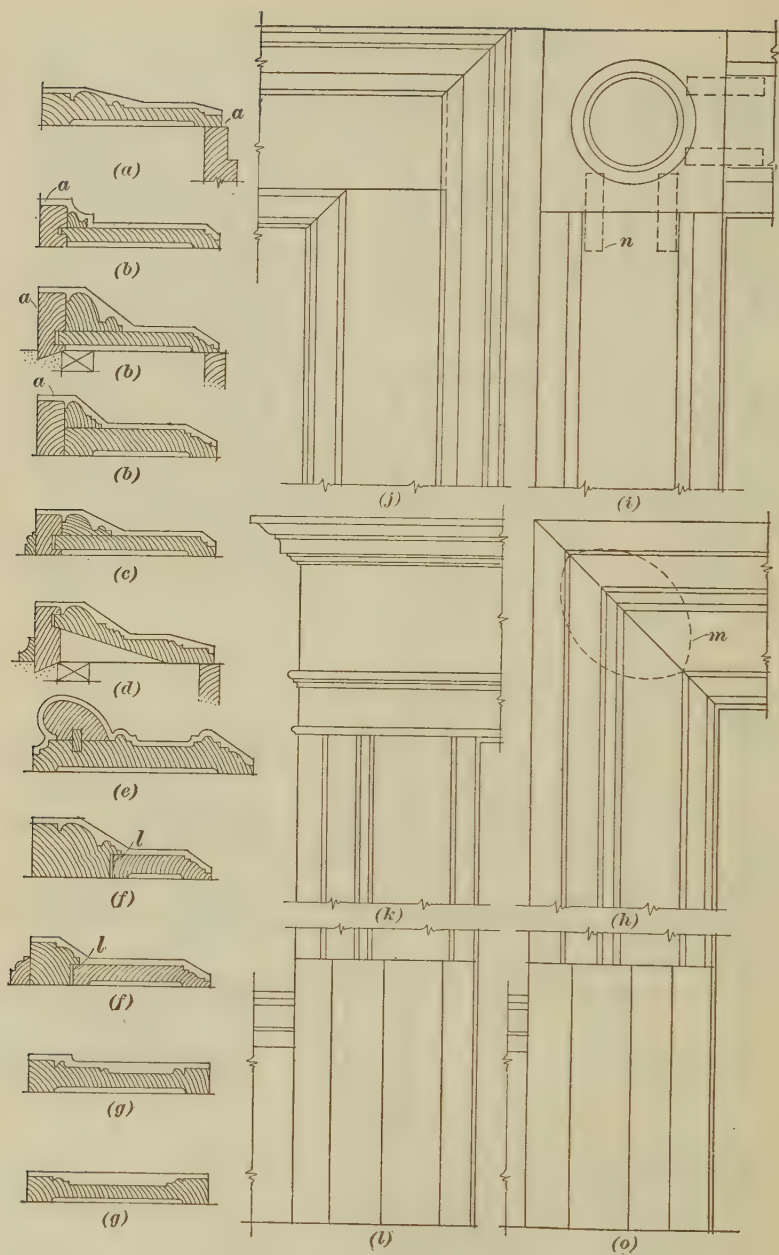


FIG. 43

and pediments are used and in which elaborate carving may be employed. A few simple casings are shown in Fig. 43.

The casings shown in (a), (b), (c), (d), (e), and (f) are used for mitered effects such as are shown in (h) and (j). In (a) the casing is made of a single strip of wood and the back is plowed out in order to prevent warping and twisting. The trim of a door is generally set back from the face of the door frame about $\frac{1}{4}$ inch, as at a, so that the butt, or hinge, when let into the face of the jamb will not cut through the trim.

In (b) are casings that are built up of three pieces, the piece a being called the *back band*. The flat member of the trim is let into the back band and a molding is planted in the corner. This construction permits the use of thin stock in making the trim, which is an economy, and the wood is not apt to curl or warp.

In (c) a similar trim is shown having a *back molding* set against the back band and scribed against the face of the plaster. The back molding is often carried around the trim of a door or window and across the top of the chair rail, base, or wainscoting.

In (d) is shown a *sprung trim*, made of two pieces of thin material; this trim shows a heavy projection and at the same time is economical of stock.

In (e) is a trim with a large ovolo as its principal feature. The ovolo is made of a separate strip and glued and splined to the body of the trim.

Forms of trim where the joint *l* is covered by a projection worked in the back band are shown in (f).

Casings, sometimes called *pilaster casings*, are shown in (g). They are generally used with corner blocks as shown in (i). The casings are butted against the blocks and are sometimes joined together by means of round dowels glued in, as shown at *n*.

Mitered casings made of one strip of wood are generally mitered together as shown in (h). A hardwood spline, or tongue, *m* should be inserted into grooves cut in the ends of the casings by a circular saw. The spline should be set with the grain at right angles to the miter cut and glued in place.

When the trim is built up of two or three pieces, as in (b), (c), and (f), the joint is best made by butting the flat face of the casing and mitering the moldings as in (j). This method of joining casings prevents the opening up of the joint due to shrinkage, which is so common with plain mitered joints.

120. Among other forms of casings, or trim, is that shown in (k), which consists of pilaster casings on the sides of the opening and a simple form of entablature over the head. This entablature is formed of a plain board with a small mold bradded or glued to the face and a small cornice molding mitered around the top.

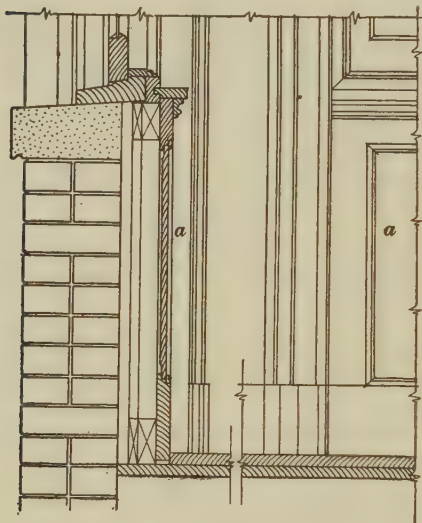


FIG. 44

In the details of windows previously given are shown examples of window finishes. Where the wall is thin, the casing is stopped on a stool with an apron and bed mold below. Where the wall is thick, as in masonry walls, jamb casings are required to fill the space between the box and the face of the plaster. When the casings are carried to the tops of plinth blocks, the trim is like that of a door.

121. Panel Backs.—Where the wall is very thick, the part under the window frame and between the jambs of the masonry opening is sometimes made thinner and the recessed surface under the window frame is paneled as shown in Fig. 44. The jamb casings and the trim of the window extend to the floor. The paneled surface *a* is called a *panel back*.

122. Plinth Blocks.—*Plinth blocks* are placed at the bottoms of casings as shown in Fig. 43 (l) and (o). This

treatment is generally used with door casings and with the casings of windows that are carried to the floor. The use of plinth blocks avoids the necessity of carrying the fine moldings of the casing to the floor, where they are apt to be filled with dirt, and provides a sufficient thickness of material to receive the base. Plinth blocks are usually shaped to match the profile of the casing, and in Fig. 43 the sections of casings in views (a), (b), etc., have profiles of plinth blocks shown on them. In the case of a pilaster casing (g) the plinth block may be a plain rectangular board, and in the casing (e) it may be elaborately molded, but should have no fine moldings or quirks.

BASES

123. *Bases, base boards, or skirtings*, are boards fitted against the walls at their intersection with the floor. In closets and unimportant rooms, the base consists of a $\frac{7}{8}$ -inch board with a simple molding on top, as in Fig. 45 (a). A quarter-round molding *b* is frequently fitted into the angle of the base and floor so as to conceal the crack that will appear if the base shrinks. Where there is a double floor, the base is set before the finished floor is put in place and the floor is fitted against the base as shown in (a), (b), and (c).

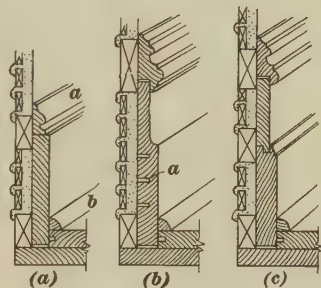


FIG. 45

In (b) is shown a more elaborate base formed of a molded board with a rich molding rabbeted on top. A still more elaborate base, consisting of three pieces, is shown in (c). Suitable grounds are shown for nailing these various bases in place. The base is sometimes sawed lengthwise through about one-half of its thickness, as shown at *a* in (b), to prevent warping and twisting. Housekeepers object to bases with projecting moldings as they catch dust; it is therefore desirable that the moldings should have as slight projections as possible.

CHAIR RAIL

124. A molded band, or *chair rail*, *a*, Fig. 46, is sometimes applied to plastered walls to prevent the backs of chairs from marring the plastering or papering. It should be about 4 inches or 5 inches in width and should be placed about 3 feet above the floor; the projection should be less than that of the door and window casings against which it runs. Suitable grounds *b* should be provided for nailing the chair rail to the wall. A loose mold is placed on top to cover the plaster joint.



FIG. 46

WAINSCOTING

125. The wall is sometimes covered for its whole height, but more often to the height of 3 feet or 4 feet, with a wainscoting. This wainscoting

may be made of marble or wood and in its simplest form consists of matched boarding crowned with a simple cap mold, Fig. 47. The matched boarding may

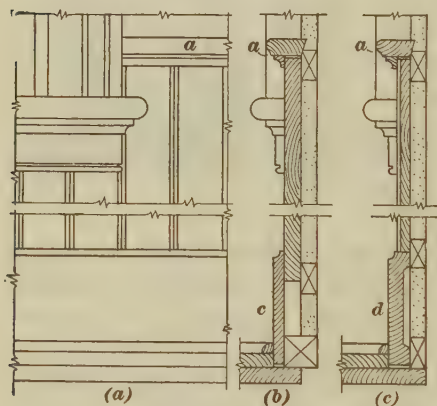


FIG. 47

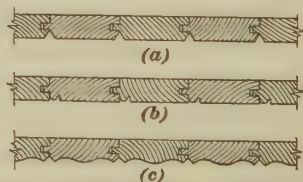


FIG. 48

have a **V** joint as shown in Fig. 48 (a), a beaded joint as in (b), or a molded face like that shown in (c). This boarding, which is also called *ceiling*, is nailed to grounds by blind nailing in the same manner as flooring. By other treatments of the

faces of the boards, various interesting effects may be obtained. A cap mold *a*, Fig. 47, is always placed on top of the boarding and is scribed to fit closely against the plaster wall. The cap should not, as a rule, project beyond the casing. A base as at *c* and *d* is sometimes run around the bottom.

Paneled wainscoting should be constructed with the same care as is used in making doors. In the best work the rails

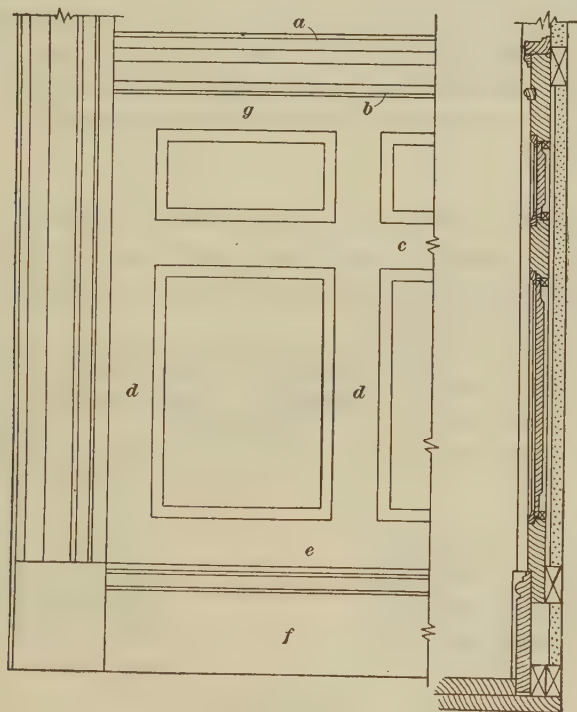


FIG. 49

and stiles are veneered and the panels made up of five thicknesses of veneer. The panels are glued up with the grain of one layer at right angles to the grain of the next layer. Paneled wainscoting should be put together at the shop and brought to the building in lengths ready to fit into position. Fig. 49 shows a detail of a paneled wainscoting with the cap *a* and a small molding *b* let in to form a frieze. At *c* is a rail,

at *d* the stiles, and at *e* the bottom rail with a base *f*. The panels should be put in as shown in Fig. 50. The molding *a* is glued to the stile, or rail *b*, which is rabbeted to receive it. The panel, having been filled and varnished or painted, is set in from the back and secured in place by means of strips of wood nailed to the stile. The panels should not be glued or nailed in place, but left free to swell or shrink. The plastering behind the wainscoting should be kept free from the wainscoting. This is accomplished by omitting the finishing coat and sometimes the brown coat of plastering.

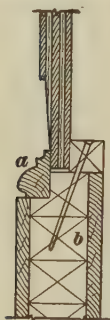


FIG. 50

INSIDE CORNICES AND PICTURE MOLDINGS

126. Cornices of wood, such as are shown at *a*, Fig. 51, are frequently used. Where false beams, as shown at *b*, are used, they are so designed that the lines of the moldings will correspond with the lines of the cornice and will miter or can be coped together.

A picture molding is shown at *c*, Fig. 51, which is one of a number of forms that are made.

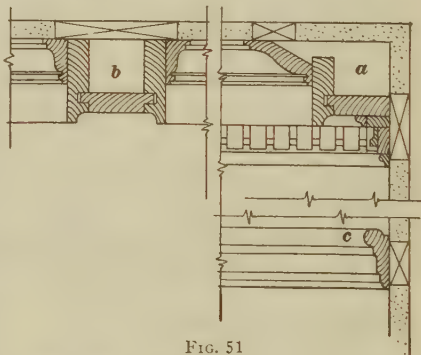


FIG. 51

MANTELS

127. Mantels may be especially designed or selected from the catalogs of manufacturers. They are made of wood, marble, stone, and imitation stone. Wood mantels are made of the same wood and finish as the trim of the room, and may be of hardwood with natural finish or of soft wood painted or enameled. Marble and stone are used for expensive man-

tels in which carving is employed; field stone is used where a rustic effect is desired. Mantels modeled after fine examples are cast in artificial stone and are shown in the manufacturers' catalogs.

ARCHITECTURAL DRAWING

(PART 2)

PRACTICAL PROBLEM

1. Introduction.—Instructions have been given in Part 1 of *Architectural Drawing* regarding the instruments and materials required to make architectural drawings. The different drawings required, as well as their purposes, have also been described. The methods of indicating the elements that make up a working drawing, and the methods used in indicating various materials, have been shown. The details of many parts of a building have been illustrated and several plates of these details have been studied and drawn by the student. To illustrate the application of this instruction, a practical problem will next be considered. This problem will consist of studying the development of a set of plans of a residence building from the time the owner or client first consults an architect or a designer until the plans are completed. A set of working drawings in the form of ten blueprints will be furnished with the Sections on *Architectural Drawing*.

For the benefit of readers who may not have the blueprints at hand, a set of plates is inserted in this book. These plates are duplicates of the blueprints, except in the matter of scale, the blueprints being at a scale of $\frac{1}{4}''=1' 0''$, while the plates are at a scale of $\frac{1}{8}''=1' 0''$.

These drawings will be studied and several of the elevations and plans will be drawn by the student. In making the drawings, the methods used will be those that are generally used in an architect's office.

2. The Problem.—A certain client or owner wishes to build a residence for himself and family and consults an architect regarding its design and erection. During this consultation the owner states his requirements as well as the amount of money that he wishes to spend for the house. His

family consists of himself, his wife, and a son 17 years of age. There will also be one or two servants. Provision must be made for these and one bedroom must be provided for guests. The following rooms are, therefore, required in order that the house shall furnish necessary accommodations.

On the first floor: a large, sunny, cheerful living room occupying one side of the house, provided with a fireplace, and having windows on three sides so as to obtain sunlight during the greater part of the day and to afford pleasant outlooks in different directions; a large comfortable porch opening off the living room which

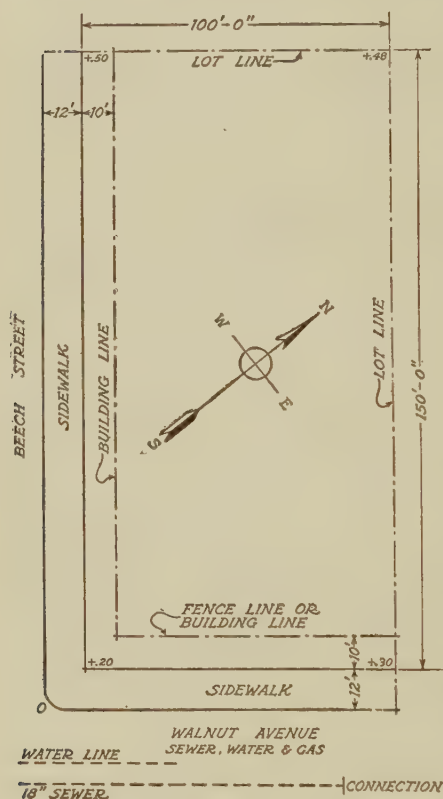


FIG. 1

can be enclosed if required and which shall be provided with a fireplace; a central hall extending through the house from front to rear, containing the main staircase; a coat closet and a toilet; a vestibule at the front door and, if possible a porch at the rear door; a dining room large enough to accommodate as many as eight people, with a breakfast porch in direct connection with it;

a closet for silver should be placed convenient to the dining room; a pantry containing a sink placed between the dining room and the kitchen, so that it will be convenient for service to the breakfast room; a kitchen containing the usual accessories, such as a closet, dresser, sink, range, boiler, ice box, etc., and opening into the hall so that a servant can answer the door bell without going through the dining room; rear stairs running from the cellar to the attic; and a rear porch at the kitchen door with a suitable roof for shelter.

3. On the second floor: A large bedroom, with two closets and a convenient private bathroom, for the owner and his wife; a bedroom for the son, a sleeping porch, and a guest room; suitable closets connected with the bedrooms; one bathroom accessible from the hall; a back hall, leading from the first floor to the servants' rooms and opening into the main hall; a servants' bedroom with a closet; a servants' bath on this or the attic floor.

4. On the top floor: One maid's room, a cedar closet, and an enclosed trunk space.

5. In the cellar: A laundry, a drying room, boiler space, two coal bunkers, and a vegetable cellar.

6. Other matters that are decided upon are that steam heat is to be used, and that the building is to have a stucco finish.

7. The owner has had a survey, Fig. 1, made of his lot, which shows a lot 100 feet×150 feet in size, and practically level. It also shows that sewer and water pipes run through Walnut Avenue. The house is to front on Walnut Avenue toward the southeast, according to the north-and-south line shown on the survey. This will assure sunlight in the living room if this room is placed on the Beech Street side of the house.

During the discussion with the client the architect who can use his pencil freely will make little sketches which, while far from accurate, will nevertheless express his ideas or the suggestions of the client in drawing, the language of the architect. Sketches such as an architect would make under these circum-

stances are illustrated in Figs. 2, 3, and 4. Fig. 2, for instance, is a rough First-Floor Plan which, for the purpose of discussion, is clear enough. Fig. 3 shows a suggestion for a treatment of the fireplace side of the living room. Fig. 4 gives a clear idea of an exterior treatment which can be made in a few moments by a skilful draftsman. Sketches such as these greatly facilitate the discussion and assist the client in formulating his ideas. They do not necessarily bind the

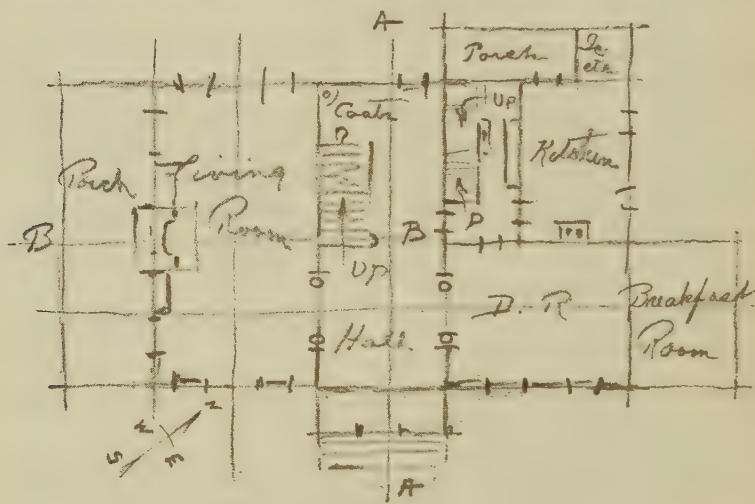


FIG. 2

architect to any final scheme, as he is still at liberty to make any improvements and further studies that may seem desirable.

8. The question of cost is always a serious one and the architect should be prepared to give a rough approximation of the cost. From the experience of himself or other architects, who have erected buildings similar to the proposed building, the architect should have some knowledge of the price per cubic foot of the building in hand. He can then roughly estimate the cubic contents of the proposed building and multiply this by the price per cubic foot and obtain an approximate cost. This will probably vary from the actual cost from 5 to 25 per cent., but the figure is as near to the actual price

as can be obtained until the drawings and specifications are completed. This approximate estimate will determine whether



FIG. 3

the client can have a stone house, a brick house, or whether he will have to build a frame house in order to obtain the accommodations that he requires. In the case under consideration the



FIG. 4

client can afford to pay for a good frame house, but he does not want clapboards or shingles.

The architect suggests a simple and dignified treatment in stucco on a wooden frame, and the client asks the architect to submit sketches of such a building as will meet the conditions and that will not cost more than a specified amount. The architect is then prepared to make the preliminary studies and sketches.

PRELIMINARY STUDIES

9. As the first process before making the preliminary sketches to submit to the client, the architect, or the draftsman who may be selected to work up the sketches, generally makes small studies called *preliminary studies*, either in freehand drawing or at a small scale. An example of such a study is shown in Fig. 5. This study is made on ruled paper and in making this sketch each square was considered as being 5 feet×5 feet. This enables the architect to draw the various parts of the building at their approximate sizes without using a scale. A fairly accurate and satisfactory study can thus be made and several such studies can be tried and criticized. The preliminary studies serve to demonstrate to the architect, himself, the various solutions that are possible under the conditions and enable him to select the best solution of the problem. The preliminary studies are not shown to the client or owner.

When a satisfactory scheme has been found, preliminary sketches can be laid out on a larger scale, such as $\frac{1}{8}$ inch to 1 foot, and worked out more carefully.

PRELIMINARY SKETCHES

10. When a satisfactory scheme has been determined upon, the next step is to make a set of preliminary sketches for the owner. These will show the plans and elevations to their best advantage and are made for the purpose of showing the client the architect's conception of a building that will meet his requirements. The preliminary sketches generally include a perspective sketch of the front and one side of the building and

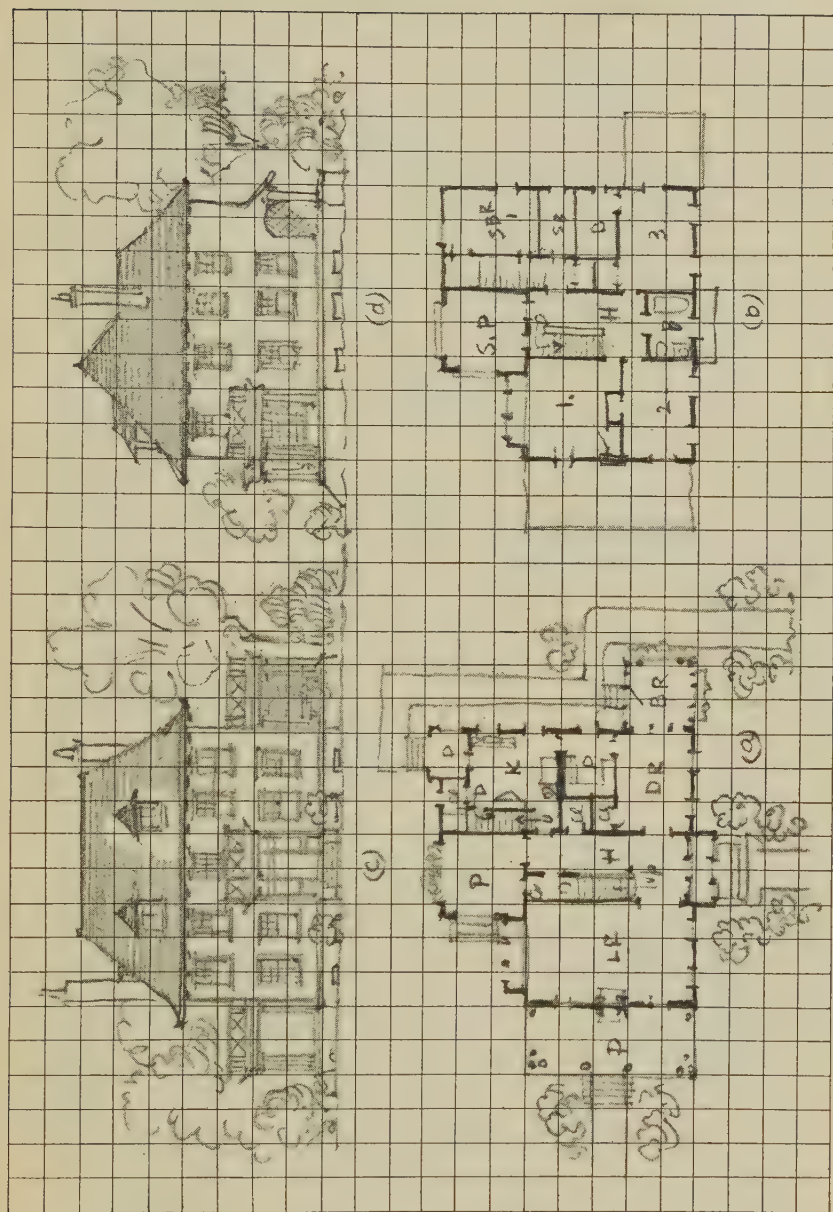


FIG. 5

represent the building to the client in its most attractive form. They also include plans that are drawn in a sketchy but attractive way. In some cases the arrangement of the gardens, walks, and other accessories is shown on the First-Floor Plan and shows the client the possibilities of development in his property. Such a drawing is shown in Fig. 6. A set of preliminary sketches nicely prepared is of the greatest help in bringing the client to a decision. It sometimes requires two or three sets of sketches to determine just what the client requires, and it will save the architect considerable labor and expense if he can bring the client to a decision with the first sketches. These sketches are also helpful to the architect, who can see from the perspective just how his design is going to look. In making these preliminary sketches the architect has an opportunity to incorporate refinements and improvements on the original ideas and to present modifications of his client's ideas that may appear desirable.

11. The process of making the preliminary sketches will next be described. Having determined upon what seems to be the best of the preliminary studies, the First-Floor Plan is laid out on a piece of tracing paper, using the $\frac{1}{8}$ -inch or $\frac{1}{16}$ -inch scale. Various parts of the building, such as walls, stairs, doors, windows, and chimneys, are laid out at their approximate sizes. The rooms are laid out at the desired sizes. The entire plan is drawn in outline, in a sketchy manner, and a second piece of tracing paper is laid over this plan upon which the second floor is laid out. The walls, stairs, and chimneys must be carried up before the rooms are laid out, as these features must be provided for in any plan. The limits of the space required for the stairs must be carefully calculated. The supports of the second-story partitions must be provided and chimneys of sufficient size to contain the flues must be drawn.

After these points have been considered, the bedrooms and bathrooms are laid out, together with closets, rear stairs, etc. It will probably be discovered that the bedrooms and other rooms do not work out properly and that a change is necessary in



WALNUT AVENUE,
 FULLY DEVELOPED PLAN
 FOR MR. JOHN G. BLANK, SCRANTON, PA.

FIG. 6

the First-Floor Plan to allow for a good Second-Story Plan. The Second-Floor Plan is modified so as to produce a good arrangement and the first floor is then changed to correspond. As these floors are the most important ones in the house, it is necessary that they be satisfactory. They should be changed and redrawn as often as is necessary until they are both satisfactory, after which a cellar plan should be started on a piece of tracing paper placed over the First-Floor Plan.

12. The elevations are next studied with regard to the principles of design. It may be necessary to change partitions, chimneys, stairs, or any of the interior parts of the plan to allow of a suitable arrangement of window openings. For this reason, it is not desirable to draw the plans too carefully until the elevations are satisfactory. In fact, the drawings of both plans and elevations should be made in a sketchy manner until the arrangement of all parts is satisfactory.

The outside of the building is seen by the public and the design should be a good example of the artistic work of the architect, as well as a credit to the taste of the owner. It should, therefore, be most carefully designed. This does not mean that the interior arrangements should be sacrificed to the exterior appearance, but that the skill of the architect should provide a good arrangement throughout. The study of elevations and of the plans should be carried on together. It is necessary, first, to obtain a good plan in the principal stories before starting the elevations. The architect should not hesitate, however, to modify his plans somewhat in order to obtain a good elevation. By sufficient study the architect should be able to obtain good elevations as well as good plans.

When all these drawings have been studied so as to produce satisfactory results, the finished preliminary sketches that are to be shown to the client are begun. It is these drawings that should be finished so as to be attractive and satisfactory to the client. They need not be drawn accurately, but they should have been studied so that accurate working drawings may be made from them without the necessity of making vital changes in the arrangements of the parts.

13. Examples of Preliminary Sketches.—Figs. 6 to 8 show examples of the preliminary sketches that are submitted to the client. Fig. 6 is a First-Floor Plan of the house, together with a layout for the entire lot. This plan shows how the various requirements for the comfort of the client and his family are provided for not only with regard to the building, but also in the arrangement of the grounds. Clients too often neglect to consider what should be done with the treatment of the lot, and many architects also do not pay much attention to this subject. The architect can exert considerable influence upon a client in persuading him to give his lot architectural treatment. The appearance of the house is often marred or spoiled by inappropriate surroundings, hence it is of considerable importance to the architect that his house shall be properly set. By planting bushes, trees, and building pergolas, fences, or walls, objectionable features in the neighborhood can often be successfully hidden, and the desirable views improved.

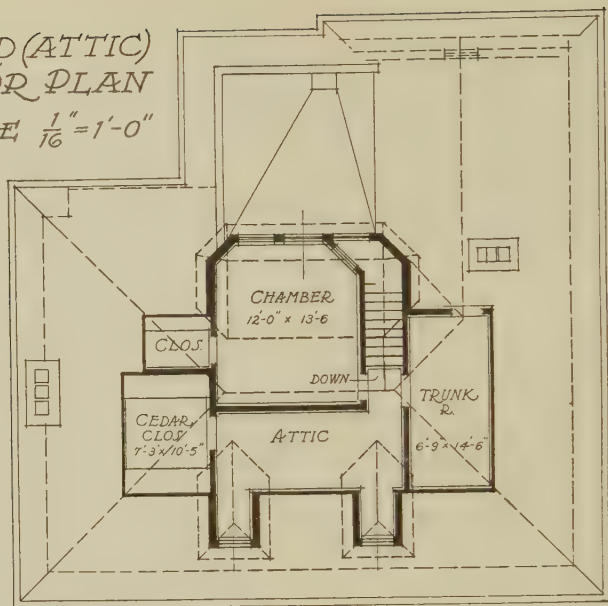
In Fig. 6 the house is shown with the walls filled in with black ink. They may be colored in water colors, if desired. The rooms are named in neat lettering and their sizes marked. The plumbing fixtures are indicated in lines and the tile floors in the porches are shown. The boundaries of the lot and the sidewalks are shown. Trees are indicated on the front lawn, and bushes, hedges, etc. in the rear. At the rear of the house grass plots and paths are shown in a neat design with a sun dial and a fountain. A pergola over which vines may be trained is also indicated. At the extreme rear of the lot is a vegetable garden and a garage. A paved yard is shown in front of the garage. A clothes yard for drying clothes is placed at the north of the building and near the steps to the cellar.

A drawing such as this will give the owner a suggestion as to how he may make his property very attractive, and, instead of confining his home to the house, he may develop his entire property so that he will receive enjoyment from it all.

14. The second floor, shown in Fig. 7, is a simple drawing showing the walls of the building blackened in and the fixtures,

THIRD (ATTIC) FLOOR PLAN

SCALE $\frac{1}{16}" = 1'-0"$



SECOND FLOOR PLAN

SCALE: $\frac{1}{16}" = 1'-0"$

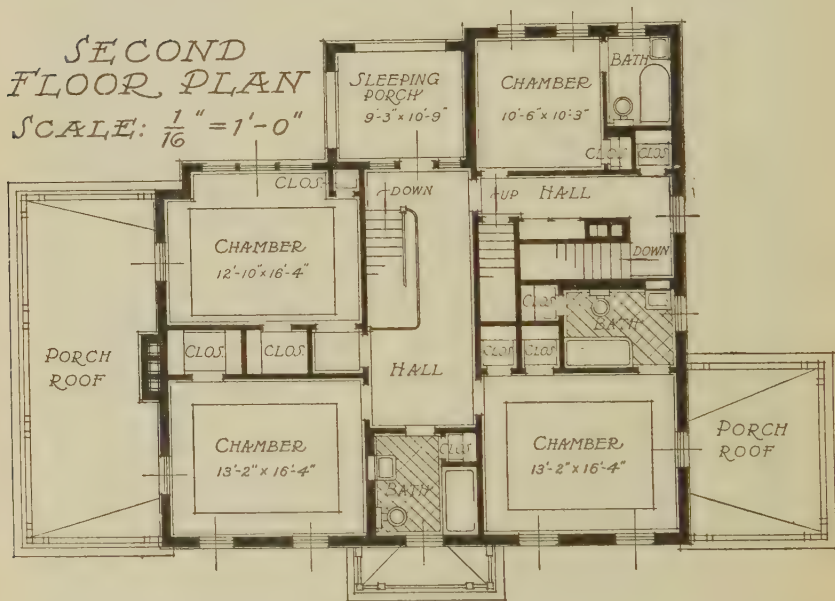
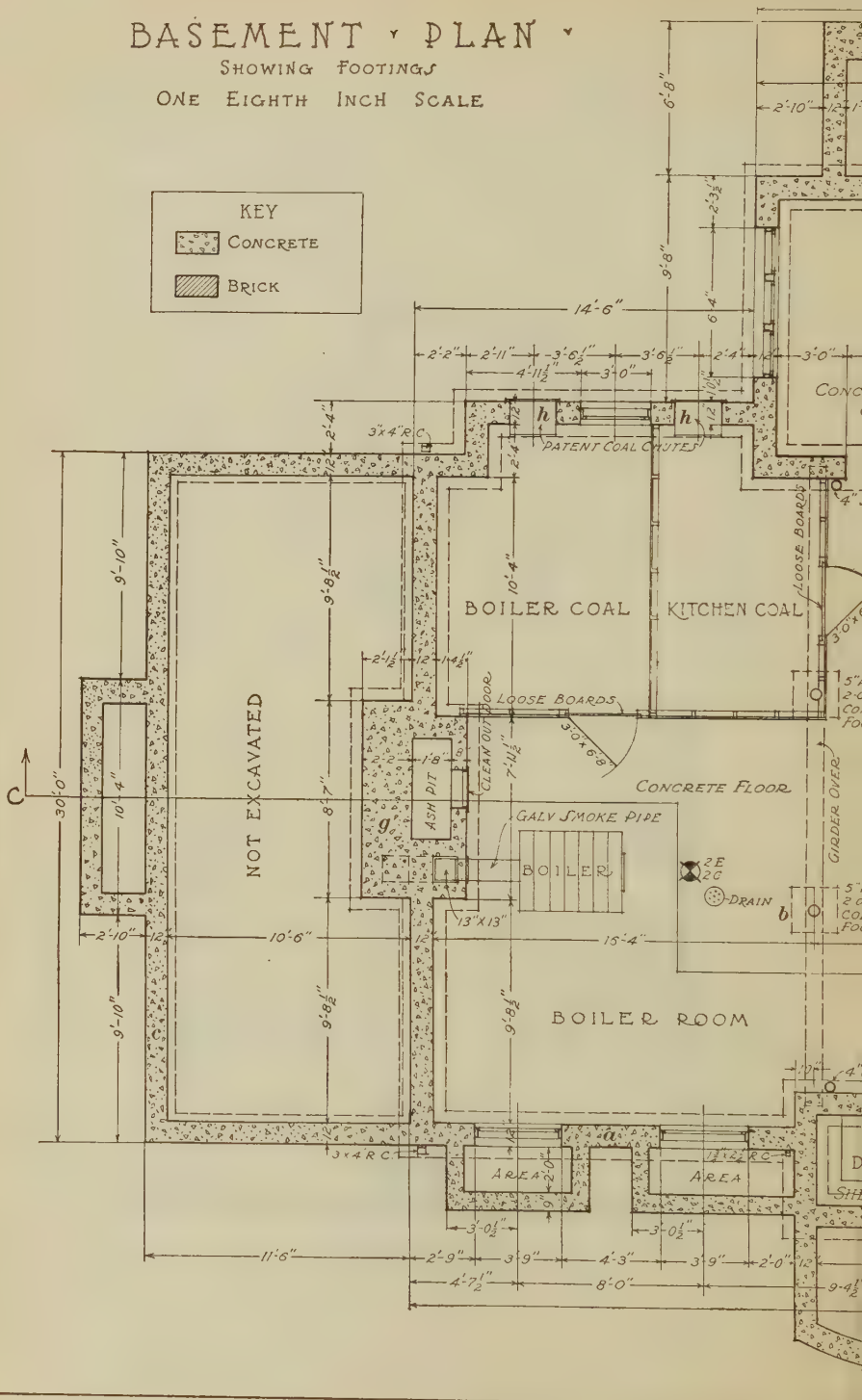
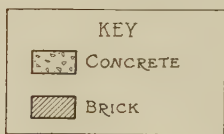


FIG. 7

BASEMENT PLAN

SHOWING FOOTINGS

ONE EIGHTH INCH SCALE



stairs, etc. shown in line. It is neatly lettered and the sizes of the rooms marked. It is a good idea to mark the sizes on all rooms, bathrooms, etc., as it will facilitate answering questions regarding their sizes during the discussion with the client. The Attic, or Third-Floor, Plan is also shown in this figure in the form of a preliminary sketch.

15. In showing the exterior of the house, it is generally clearer to show a perspective view giving two facades as they would appear from some convenient point of view. In a perspective drawing the paths, the planting, trees, etc., can be shown, and the client will obtain a realistic view of the proposed design. This is much more satisfactory to a client than two or three elevations which he may or may not understand.

Fig. 8 is a perspective view of the proposed house showing the building and some of the accessories. It is in this case that a knowledge of perspective drawing and of rendering is extremely useful to the architect. It is a well-known fact that a cleverly rendered perspective will be of considerable influence in winning a client over to the architect's design. It thus becomes the best method that the architect possesses to influence a client in accepting a design which the architect believes to be the best that can be made.

16. There are several mediums, such as water colors, pencil, pen-and-ink, and colored crayons, that can be successfully used in making attractive presentations of architectural drawings. Some architects can use one better than another. Fig. 8 shows a photograph of a rendering in water colors of the house under consideration. This form of rendering makes a realistic effect, as it gives not only the form and the lights and shadows, but also the color. Renderings in pencil or pen-and-ink give only the form and the lights and shadows. Nevertheless very effective drawings can be made in those mediums.

Skill in rendering drawings can only be obtained by continued practice, and the ability to make attractive drawings is of inestimable value to an architect. Architects who have not the faculty for doing this kind of work often pay high prices



FIG. 8

to have such work done for them, and a draftsman who can make good renderings in pencil, water colors, or pen-and-ink can command a good salary.

17. Submitting Preliminary Sketches.—When the architect has completed his preliminary sketches, he makes an appointment either at his office or at the house of the client, and exhibits them, pointing out how he has met the requirements and where he has improved certain arrangements. The client and his wife generally examine every feature of the plan; they see where their furniture and rugs are going to fit in and discuss all the details of the plans or elevations. It frequently happens that the clients desire some changes in the plans and elevations. These the architect carefully notes. His next duty then is to see if he can incorporate the changes in the plans as designed. If this cannot be accomplished, he may be compelled to make new sketches which will include all the points agreed upon. After this, he again confers with the client and once more the sketches are discussed in detail. It may be that slight changes are requested in these sketches, when the architect will be required again to change his sketches. It is much better to make any changes that may be required on the sketches than upon the working drawings which will be made later. The sketches are not finished very carefully and are easily changed, whereas changes in the carefully worked out working drawings may mean the loss of considerable time.

It is to the architect's advantage to have his sketches made satisfactory, as this can be done with comparatively little expense.

PRELIMINARY ESTIMATES

18. Experience has demonstrated that it is advisable before making the working drawings to obtain a preliminary estimate of the cost of the building. If the building, as shown in the preliminary sketches, is too costly, it will be useless to spend time and money in making working drawings that will surely have to be changed. A good contractor can

tell, from the preliminary sketches and a brief description of the materials for the building, the approximate cost of the building. The architect can also form a good idea of the cost if he has already designed and erected a similar building. If the cost is greater than the owner will pay, it will be much better to make changes in the preliminary sketch than to change the more expensive working drawings.

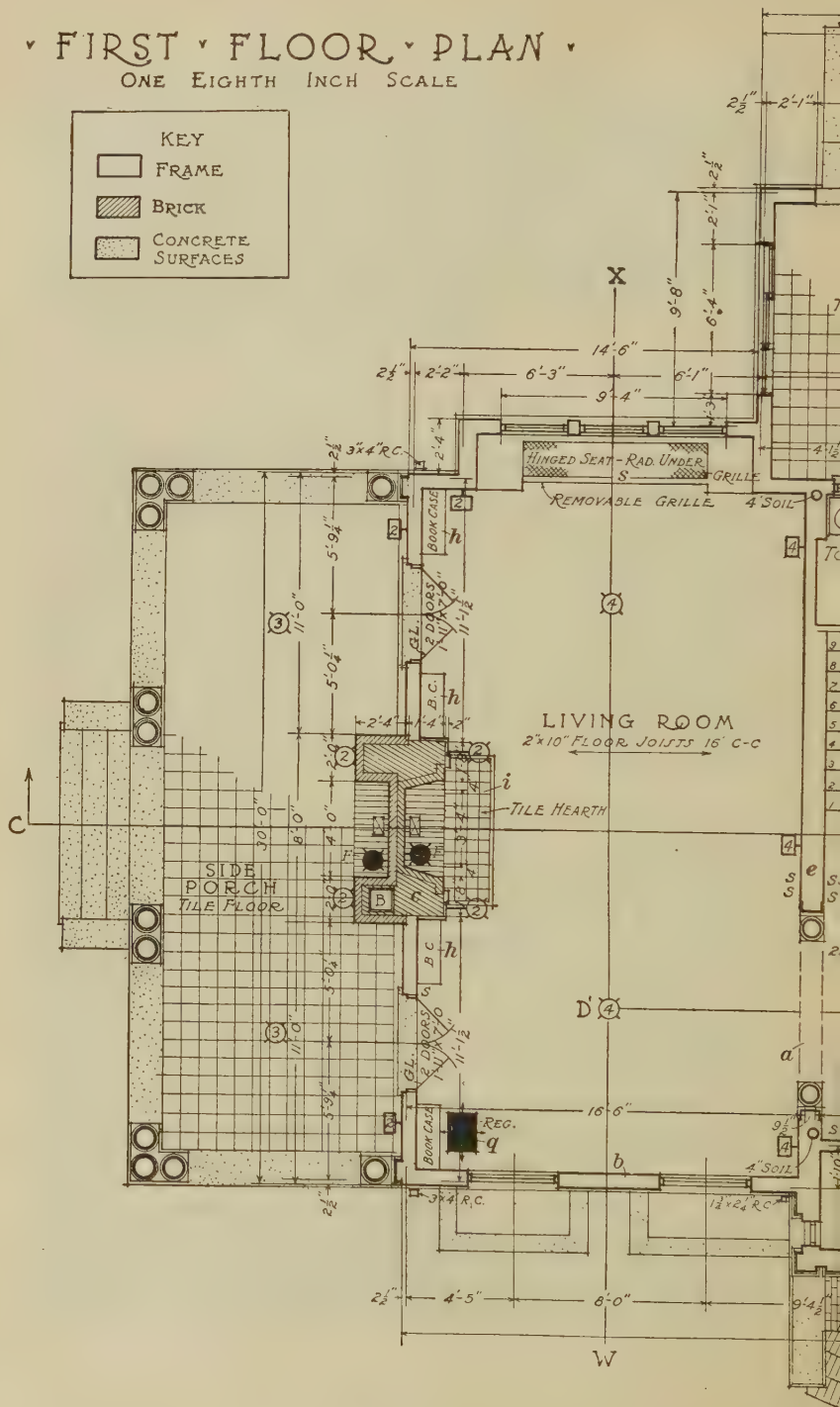
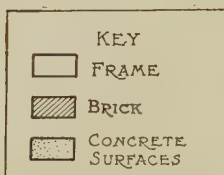
WORKING DRAWINGS

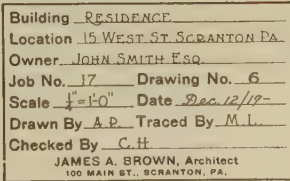
19. When the client's wishes have been met in the preliminary sketches and in the matter of cost, the architect proceeds to prepare the working drawings, which are the final drawings of the building. The working drawings must be accurately drawn and show the building with all its parts drawn to a given scale, so that the measurements can be taken from it. The method of procedure in getting up a set of working drawings is similar to that described for preliminary sketches. A more intimate knowledge of materials and methods of construction is, however, required for laying out the working drawings than for the sketches.

It will be noted that additional study is recommended at each stage in the progress of the design. The preliminary studies are very rough in character. The preliminary sketches, while showing a more complete and satisfactory solution of the problem, are still in an incomplete form. Further study, especially in matters of construction and fine points of design, is required when making the working drawings. An architect, as he studies the plans in the various stages, finds ways of improving them. He naturally incorporates these improvements in the plans. This process is kept up until the last drawing is completed. It is this study and improvement that gives an architect's plans their value.

20. In making a set of plans or working drawings the First-Floor Plan is generally drawn first, then the Second-Floor Plan. After these are roughly drawn, the elevations are next made. The arrangement of windows, doors, and other

▼ FIRST FLOOR PLAN ▼ ONE EIGHTH INCH SCALE





openings is best determined on the elevations. When a desirable arrangement of openings is found on the elevations, these openings are drawn on the plans. When so drawn it may be necessary to make corresponding changes in the plans. The plans and elevations should be thoroughly studied and compared until they are all satisfactory, and the best possible results are obtained. This work may require more than one drawing of each plan and elevation, but these study drawings or studies need not be made as carefully as the final drawings. The final, careful, and accurate drawings should be made only after all the necessary study and consideration have been given to the design, and there is nothing to be gained by further study. The Basement Plan is made to conform to the First-Floor Plan, and the Attic Plan to the Second-Floor Plan.

In the blueprints, as well as in the plates in this Section, are shown finished plans after the proper amount of study has been put on them. They represent the architect's final arrangement and the sizes of the various parts of the building, and are in shape to be used as contract drawings.

PLATE I, TITLE: FIRST-FLOOR PLAN

21. The next step now will be to proceed to study the series of working drawings given in the following pages and in the accompanying set of blueprints and the student will be required to draw several of them and send them to the Schools for criticism. He will be amply repaid for all the care and study that he puts on this part of his work. It is perhaps the most essential and necessary part of his training, since it fits him to express architectural ideas in a practical and useful manner.

22. The successful completion of the drawings required in *Architectural Drawing*, Part 1, should qualify one to perform the technical part of the drawings called for in this Section. The actual drawing of the lines and indications should be comparatively easy, and greater attention should be given to the ideas that are to be shown by the drawings than to the process of making the lines and indications. The study of the

building trades and the processes used in building should be of great value in laying out the proper sizes and construction on these drawings.

23. Drawing is the means used by an architect to convey definite ideas to the client, contractor, and others who may take any part in the erection of a building. Every dot, line, or other indication placed on the paper should, therefore, have a definite meaning to all persons using the drawings.

24. Symmetry.—At this point it is advisable to discuss the subject of symmetry as it is used in several instances in drawing the plans and elevations of the building that is being studied. Symmetry is often a very important and desirable feature in good design. In the South Elevation the arrangement of the various features is symmetrical. If a line is drawn vertically through the center of the doorway, it will divide this elevation into two equal and similar parts, the one to the left of the line being the reverse of the one to the right. The line is called the *axis* of the elevation.

For each feature on one side of the axis there is a similar one on the other side, equally distant from the axis. These features are said to be symmetrical with reference to this axis. The doorway and the windows above are divided into two equal parts by this axis. The windows of the dining room and the living room which appear in this elevation are symmetrical with reference to this axis. The same is true of the bedroom windows above and the basement windows below.

A slight difference occurs in the details of the porches on the east and west ends of this elevation, but a symmetrical effect is secured by making the outlines the same, and by keeping the columns, cornice, and balustrades similar.

The chimneys do not count as part of this elevation, as they are located at different distances back of the building. The South Elevation may be considered as a symmetrical design.

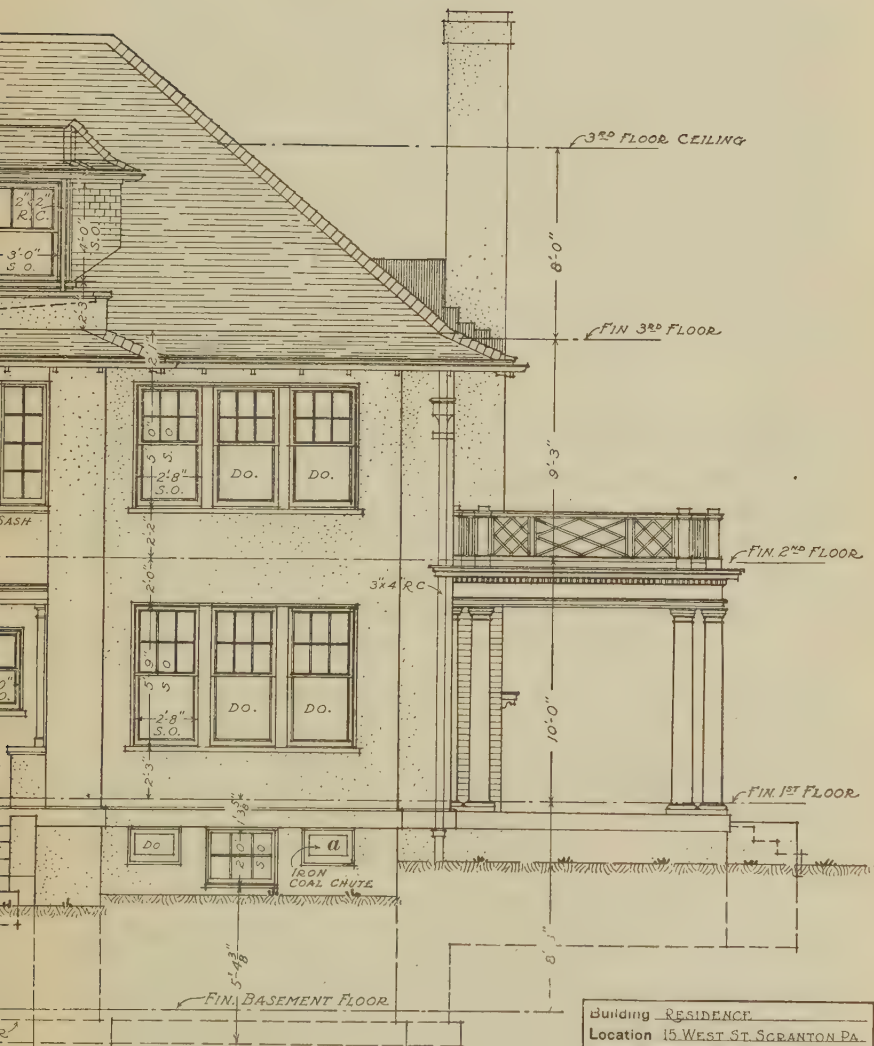
A facade treated symmetrically generally has a restful, dignified, and elegant effect.

25. Symmetry is also observed in the design of the exterior of the living-room wing as shown on the West Elevation. If

◀ NORTH ELEVATION ▶

ONE EIGHTH INCH SCALE





Building RESIDENCE
 Location 15 WEST ST. SCRANTON PA.
 Owner JOHN SMITH ESQ.
 Job No. 17 Drawing No. 4
 Scale 1/4" = 1'-0" Date Dec. 12/17-
 Drawn By A.P. Traced By M.L.
 Checked By C.H.
 JAMES A. BROWN, Architect
 100 MAIN ST., SCRANTON, PA.

an axis is drawn vertically through the center of the chimney, the features of this wing will be seen to be symmetrical with reference to this axis.

The requirements of a dwelling do not generally allow a symmetrical treatment throughout, and such a treatment is rarely attempted. Nevertheless, symmetry can be used in the principal parts where a quiet, dignified effect is desired.

26. Symmetry in Plan.—In a previous article it was stated that the rooms on the first floor are most important and should be designed with reference to proportion, symmetry, and beauty. In simple homes, good proportion and symmetry can be obtained by a skilful arrangement of the plan and need not cost more than poorly proportioned or unsymmetrical plans. Good proportions and symmetry are largely conducive to beauty in a room.

27. In the blueprint of the First-Floor Plan a general symmetry has been maintained. The walls of the living room and the dining room are symmetrical with regard to the principal axis AA' ; that is, the walls of the hall are equidistant from the axis AA' ; and the walls of these rooms opposite the hall are equidistant from the axis AA' . The main-entrance doors and the vestibule are symmetrical with the same axis. This axis may be said to cut them into two equal parts.

28. The living room is designed with reference to the two axes WX and CC' . The left-hand wall is exactly symmetrical with respect to the axis CC' , while the front windows and the bay window in the rear are symmetrical to the axis WX . Thus, three sides of this room are symmetrical and the room, in general, will have a symmetrical effect.

29. The dining room has its four walls designed so as to be exactly symmetrical with respect to the axes of the room, UV and $D'D$. For instance, the front windows are at equal distances each side of the axis UV , as are the doors to the closet and the pantry. The sliding doors are balanced on the axis $D'D$. The doors and windows on the breakfast-room side are also arranged symmetrically with regard to the axis $D'D$. Thus,

each of these walls will be dignified and can be decorated so as to make beautiful walls.

30. The breakfast porch is similarly designed with reference to the axes $D'D$ and YZ .

31. Symmetry is not applicable throughout the entire building and it should not be attempted. The service portion of the first floor, that is, the pantry, kitchen, etc., should be arranged for service and convenience rather than for symmetry.

32. The bedrooms should be arranged for convenience first, and symmetry should be employed where it can be conveniently obtained.

The windows of these rooms should be treated with reference to the exterior composition in any case and should be designed with reference to their effect on the exterior appearance of the building.

33. The reason for emphasizing the matter of symmetry at this point is that symmetry can best be introduced into the drawings when starting to lay out the plans of a building. It is also brought out so as to impress the student with the value of drawing axes, such as AA' , WX , UV , etc., in certain parts of the plan and working from them in laying out the windows, doors, and other features, especially in the more important rooms of the house.

Axes are used in the elevations in laying out the windows. Thus, in the South Elevation, the windows of the living room and the dining room are located on this elevation with reference to the axes of these rooms. Axis lines of the four windows should be drawn in faint lines on the elevation and the basement and second-floor windows laid out on the same axes as the first-story windows.

In the West Elevation the axes of the living-room windows should be drawn faintly and the second-story windows laid out on these axes. The same method should be used wherever one window should be directly over the one below.

34. Methods of Procedure.—The drawing board should be covered with a sheet of detail paper or good wrapping

paper free from wrinkles and creases. A roll of tracing paper 36 inches in width should be purchased, and by dividing it in half, 18-inch widths of paper will be obtained. Cut off a piece 18 inches $\times$ 22 inches, and tack it on the detail paper. The finished size of the sheet will be 15 inches $\times$ 20 inches. The thumbtacks should be placed outside this 15" $\times$ 20" space. The drawing of the First-Floor Plan can then be started.

35. The drawings are to be drawn at the scale of $\frac{1}{4}$ inch to 1 foot, which is the scale commonly used in laying out working drawings of this kind in architects' offices. The drawings are to be made like the accompanying blueprints or the corresponding drawings in this Section.

36. Lay out with light pencil lines a rectangle 15 inches $\times$ 20 inches in size. The first lines of the drawing will be measured from these lines.

Draw a faint axis line AA' , 10 $\frac{1}{4}$ inches from the left-hand line. The line AA' is the center of the hall and practically the center line of the building.

37. Walls.—The outside line of the front wall is actually 2 $\frac{1}{2}$ inches above the lower border line. Draw this line faintly, making it somewhat longer than the front wall of the building. On this wall line lay off on each side of the line AA' a distance of 22 feet, at the scale of $\frac{1}{4}$ inch to 1 foot, and mark these points. Through these points draw lines toward the rear of the house, using the triangle. Mark off on the left-hand line 30 feet and on the right-hand wall 43 feet. Through the 43-foot mark draw a line to the left, using the T square, making it 17 feet 8 $\frac{1}{2}$ inches. This line will locate the rear wall of the kitchen closet.

From this point draw a line toward the front of the house 12 inches long, using the triangle. From that point draw a line to the left 11 feet 9 $\frac{1}{2}$ inches in length. This line will be the rear wall of the rear porch. Draw a line toward the front of the building, 9 feet 8 inches in length, another line 12 feet 4 inches in length to the left for the rear of the living-room bay window. Then draw a line 2 feet 4 inches toward the front and a line 2 feet 2 inches toward the left. The end of this

latter line should meet the end of the 30-foot line of the left wall of the living room.

These lines should be drawn faintly, as the doors, windows, etc. have not been laid out. After the doors and windows are laid out, the parts of these lines that are to remain are strengthened and the unnecessary parts erased.

38. Thickness of Outside Walls.—The thickness of the outside walls should next be shown. This thickness depends upon the construction of the walls, which is shown in Fig. 9. In drawing the thickness at the scale of $\frac{1}{4}$ inch to 1 foot, small fractions of an inch are disregarded. In Fig. 9 the studs are shown as 4 inches, the inside plastering about $\frac{7}{8}$ inch, the outside sheathing as $\frac{7}{8}$ inch, the outside furring strips as $\frac{7}{8}$ inch, and the stucco as $\frac{7}{8}$ inch. The total of these dimensions is $7\frac{1}{2}$ inches. Any of the above dimensions may vary slightly. It will be assumed that the work outside the studs, including the sheathing, furring, and stucco, will occupy about $2\frac{1}{2}$ inches, and the stud and the inside plastering are 5 inches thick. The thickness of these outside walls will, therefore, be shown as $7\frac{1}{2}$ inches. In many places on the plan the $2\frac{1}{2}$ -inch distance is shown, so that measurements can be taken from the faces of the studs in laying out framing, windows, etc.

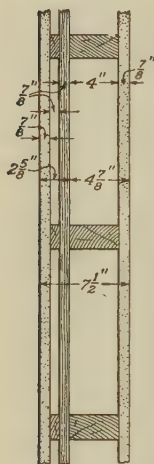
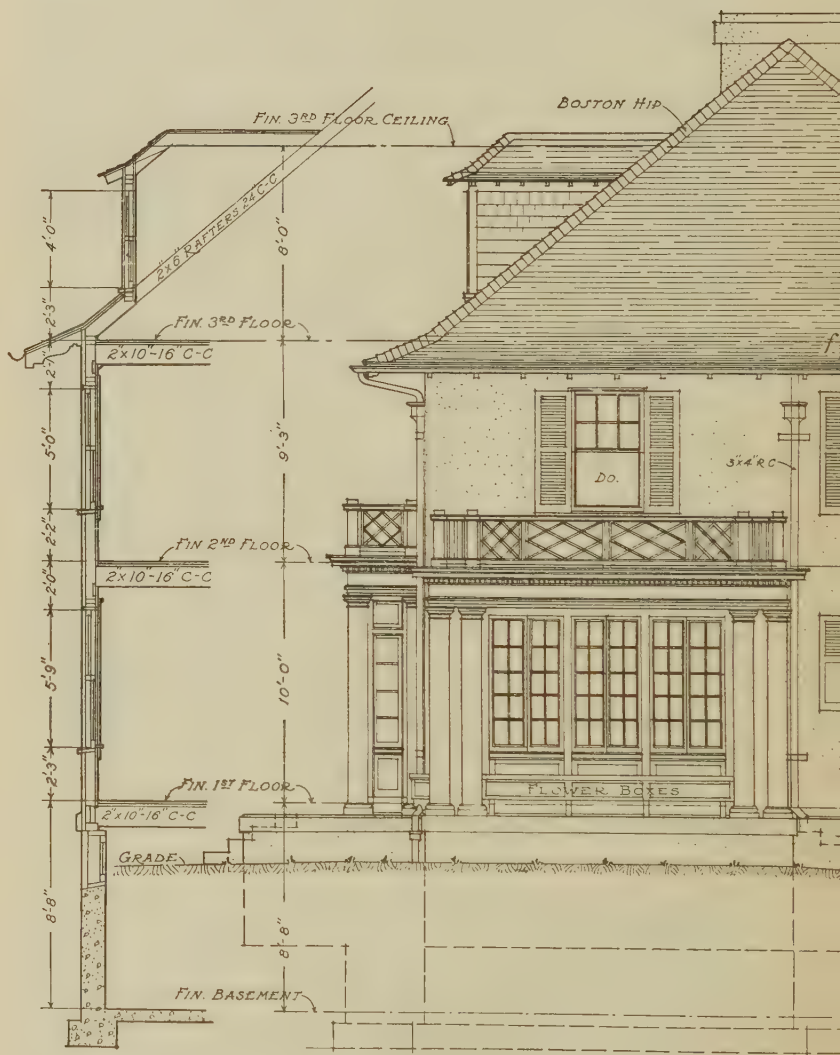


FIG. 9

Draw lines $7\frac{1}{2}$ inches inside the outside lines already drawn. These lines also should be drawn lightly until all the openings, etc. are determined. The lines on the outside of the walls represent the projecting water-table which is shown on the elevation.

39. Axes.—The axis lines CC' , WX , $D'D$, UV , and YZ should now be drawn in lightly. The axis CC' is 15 feet from the face of the front and back walls of the living room. The axis WX is 9 feet $4\frac{1}{2}$ inches plus 4 feet 0 inches, which is 13 feet $4\frac{1}{2}$ inches, to the left of the axis AA' and parallel with it. The axis UV is 13 feet $4\frac{1}{2}$ inches to the right of the axis AA' and parallel with it. The axis YZ is 5 feet 8 inches to

✓ EAST ✓ ELEVATION ✓ ONE EIGHTH INCH SCALE





Building RESIDENCE
 Location 15 WEST ST. SCRANTON PA.
 Owner JOHN SMITH ESQ.
 Job No. 17 Drawing No. 3
 Scale $\frac{1}{4} = 1'-0"$ Date Dec. 12/17-
 Drawn By A.P. Traced By M.L.
 Checked By C.H.
 JAMES A. BROWN, Architect
 100 MAIN ST., SCRANTON, PA.

the right of the face of the building. The axis $D'D$ is taken through the middle of the dining room and is found as follows: The dimensions 14 feet 8 inches from the front to the back of the dining room includes 5 inches of the front wall and 3 inches of the partition between the dining room and the pantry. Deduct 5 inches + 3 inches, which is 8 inches, from 14 feet 8 inches, and the width of the dining room is 14 feet. The axis $D'D$ will, therefore, be 7 feet from the inside of the front wall of the dining room, or 7 feet $7\frac{1}{2}$ inches from the outside of the wall.

40. Partitions.—The partitions on interior walls are generally constructed of studs 2 inches $\times$ 4 inches and plastered on both sides. The total thickness is generally from $5\frac{1}{2}$ to 6 inches and they are shown 6 inches thick in most places. Where the dimension of a partition is not marked, it is generally intended to be 6 inches thick. The partition between the dining room and the pantry, also the partition between the coat closet and the hall, is 6 inches thick. The partition between the coat closet and the pantry is 4 inches in thickness and is formed by setting the studs so that the 2-inch dimension is perpendicular to the thickness of the wall. The partition between the hall and the living room is of a special thickness on account of the use of the columns in the opening and to accommodate plumbing pipes. There are partitions of special thickness between the pantry and stairs to the cellar, and between the dining room and hall.

In drawing these partitions, those each side of the hall should be drawn first. The thickness of these partitions is given at the front end of the hall, and is $9\frac{1}{2}$ inches. This is, however, the size from face of stud to face of stud, and does not include the plaster. Considering the plaster on both sides of these partitions as 1 inch in thickness, the partitions will be drawn $11\frac{1}{2}$ inches in thickness. The hall sides of these partitions are 4 feet 6 inches from the center line AA' to the studs, or 4 feet 5 inches to the plaster. Draw lines 4 feet 5 inches each side of AA' extending through the hall, which will show the finished width of the hall.

Draw the hall partitions $11\frac{1}{2}$ inches in thickness in faint lines; check them up with axes WX , AA' and UV . Thus, the inside lines of the west wall and the hall partition should be equally distant from the axis WX . The insides of the dining-room walls should likewise be equally distant from the axis UV . The walls of the hall should be equally distant from the axis AA' . The inside lines of the front and rear walls of the living room should be equally distant from the axis CC' . If this does not check up, all the measurements should be gone over carefully and any errors remedied. The rear wall of the dining room should be 7 feet back of the axis $D'D$. When the walls, partitions, and axes are all correctly laid out, the remaining details of the plan can be drawn.

41. The hall partition at the toilet should be made 6 inches thick so as to provide more space in the toilet. The hall partition at the right should be made 6 inches thick from the dining-room closet to the rear of the hall. The outside wall between the kitchen and the rear porch, and the kitchen closet and the rear porch should be $7\frac{1}{2}$ inches thick.

42. Windows.—The windows may now be drawn. Lay off the front windows of the dining room with the centers, or axes, 4 feet each side of the axis UV . These are double-hung windows and should be indicated accordingly. The widths of these openings are obtained from the South Elevation, the sash opening, 3 feet 6 inches, being the dimension required for these windows. Lay off the axes of the French windows from the living room to the side porch according to the figures on the plan which locate these axes. The width of these openings is twice the width of one of the sash, or 2×1 foot 11 inches, or 3 feet 10 inches. The indication is for a French window. The windows in the bay in the north end of the living room are double-hung and are 2 feet 8 inches wide as shown on elevation, the mullions being 11 inches wide. A sliding window is shown on the west side of the rear porch, the opening being 6 feet 4 inches and the indication is shown on the blueprint. In the west wall of the kitchen is a high window which is indicated by dotted lines

as shown in Plate I of *Architectural Drawing*, Part 1. The windows in the kitchen closet, the kitchen, and the pantry are regular double-hung windows and are so indicated.

In the breakfast porch are casement windows opening outwards. The axes of these windows are located by the dimensions on the plan and the sizes in most cases are given on the different elevations. Where the sizes are not noted, they may be measured and laid out accordingly on the plan that is being drawn. The elevations should be referred to if there are any doubts as to the nature of these different windows. The sizes of the porch windows are not shown on the First-Floor Plan, as these widths are not determined until the scale details are made. The detail of this porch has already been studied in *Architectural Drawing*, Part 1, and should be referred to while making the drawing of the porch on the First-Floor Plan. From this detail the sizes of the window openings and other parts of this porch can be obtained.

43. Doors.—The partition where the sliding doors occur has been drawn $11\frac{1}{2}$ inches thick. For the purposes of this drawing, divide this thickness into three equal parts and draw the pockets for the doors, as shown. The width of the door opening is equal to the width of the doors, or 2×3 feet = 6 feet. The door is marked 2 feet 3 inches, in error on the plan. The pockets should be made about 3 feet 4 inches deep. Draw single lines to indicate the actual doors, making them 3 feet in length. These doors are then marked with their sizes as shown, the horizontal dimension, or width, being placed first, and the size of one door given. All the swinging doors are indicated by lines drawn so as to show the side on which the door is hung and the direction in which it swings. The sizes are marked as shown. Where doors swing into two rooms, as the door between the dining room and the pantry, they should be drawn as indicated.

44. Swing of Doors.—In domestic buildings all outside doors should swing into the house. In schools, churches, and other buildings where numbers of people gather, the outside doors should open outwards so as to permit of easy

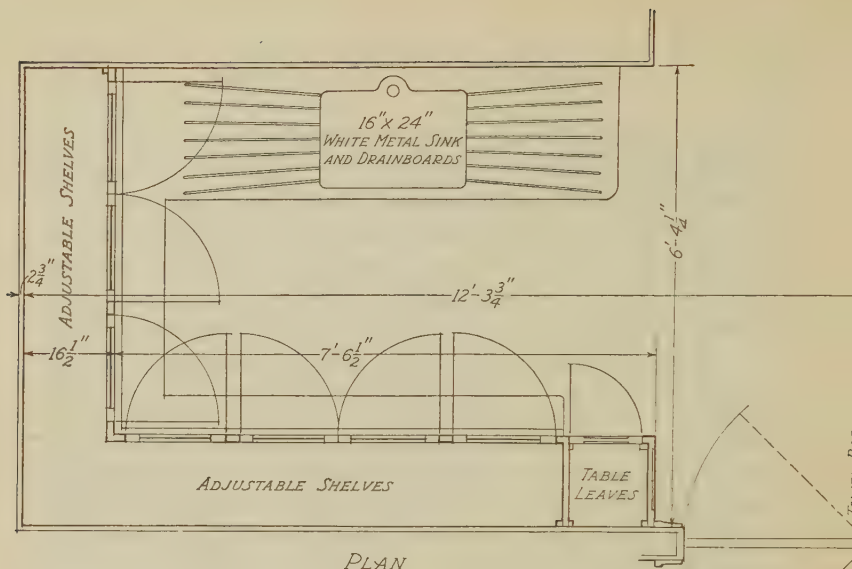
exit in cases of emergency or panic. Doors to the principal rooms of a house generally open into the room. They should, when possible, open against walls where they will be out of the way. Doors to bathrooms generally open into the bathrooms, and doors to closets open out of the closets into the rooms. Doors to closets should open so that light may shine directly into the closets. Doors to bedrooms should open so that the bed cannot be seen, if this is otherwise convenient.

45. Trim of Doors.—It should be remembered that the trim of doors as well as of windows extends 4 inches or more on each side of the opening. Consequently in placing a 3-foot wide door, a space 3 feet 8 inches or more will be required to provide properly for the door and the trim. When locating doors on a plan in the corners of rooms, a space of 4 inches or more should be allowed between the door opening and the adjacent wall, as shown in the doors from the hall to the kitchen and from the pantry to the kitchen. In important rooms it is always safer to allow 10 or 12 inches between the opening and the wall, to take more elaborate trims.

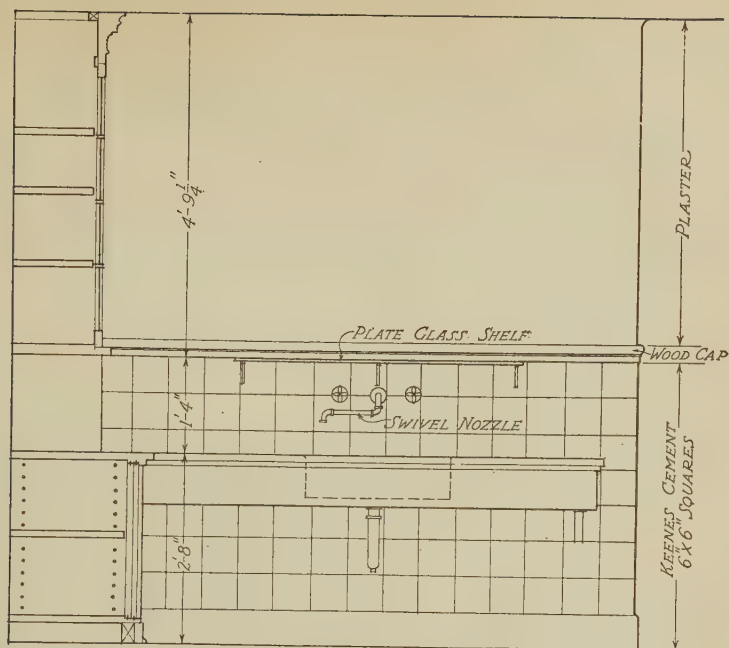
Where a door is to be fitted with a glass panel, the fact is noted on the plan by the letters *GL.* or the word *Glass* marked at the door on the plan. The glass is shown on the elevations of the door. The nature of the glass is specified and the size and shape given on scale details. The doors of the dressers in the pantry and the kitchen are shown in their proper places. The sizes of these doors are, however, not marked on the drawing, but are determined and shown on the scale details, as illustrated in Fig 10.

All the doors should now be carefully drawn in, as shown on the blueprint. The doors may be shown open at an angle of 45 degrees or 30 degrees, as convenient. As a rule, it is best to have them all drawn at the same angle.

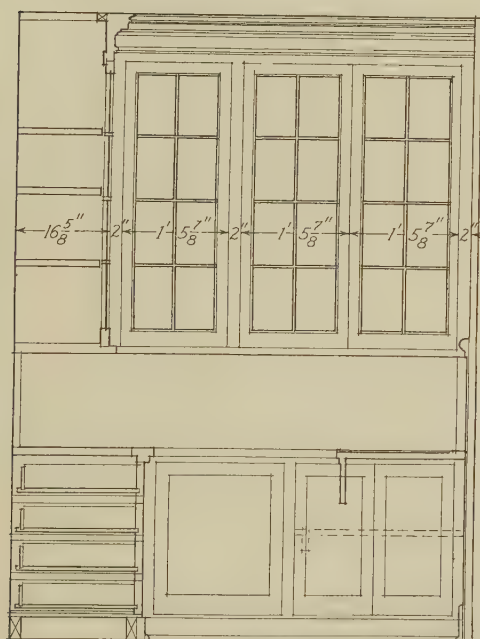
46. Pantry.—The pantry is a very useful connecting link between the dining room and the kitchen. It is a convenient place to keep the china and to wash the china after it has been used. For this latter purpose a pantry sink is provided. The pantry sink may be of porcelain or galvanized iron.



LEFT SIDE ELEVATION



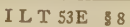
RIGHT SIDE ELEVATION

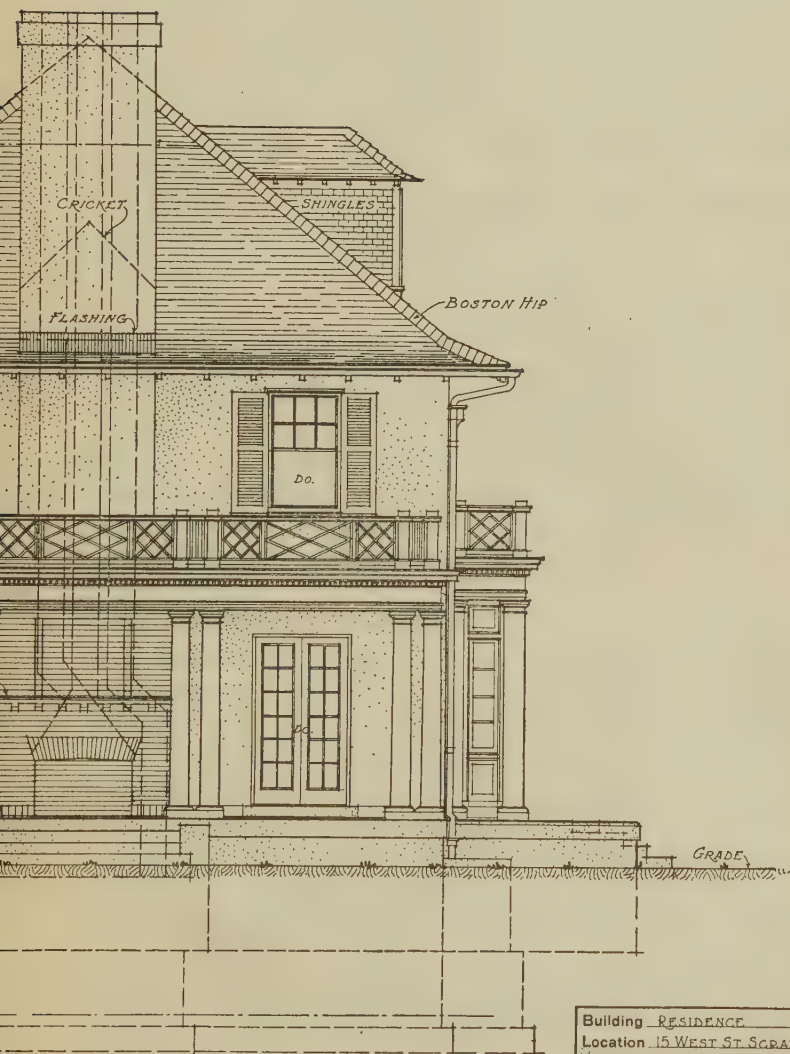


END ELEVATION

PANTRY - DRESSER - DETAILS
THREE EIGHTH INCH AND THREE QUARTER INCH SCALE

ONE . EIGHTH INCH SCALE





Building <u>RESIDENCE</u>	
Location <u>15 WEST ST. SCRANTON PA.</u>	
Owner <u>JOHN SMITH ESQ.</u>	
Job No. <u>17</u>	Drawing No. <u>2</u>
Scale <u>1/2" = 1'-0"</u>	Date <u>Dec. 12/12-</u>
Drawn By <u>A.P.</u> Traced By <u>M.I.</u>	
Checked By <u>C.H.</u>	
JAMES A. BROWN, Architect	
100 MAIN ST., SCRANTON, PA.	

Pantry sinks may also be made of white metal or copper. Generally the pantry sink is provided with a stopper or a standing waste so that glassware can be washed in the sink itself without using the dishpan. If the sinks are of very hard material such as porcelain, china, or heavy cast iron, there is a great risk of breaking glassware and fine china. Pantry sinks are, therefore, often made of thin sheet metal such as copper or white metal, which is more yielding and reduces the risk of breakage. The pantry sink should have an ample drain-board.

A pantry should have counter shelves with a suitable space above. This is used in serving food, etc., and later on for receiving the soiled dishes, glassware, etc.

A detail drawing of the pantry shown on the First-Floor Plan is given in Fig. 10. This drawing will give a clear idea of what is indicated in the $\frac{1}{4}$ -scale plan. In making the drawing of this pantry on the plan this detail should be carefully studied. Better still, a detail drawing like Fig. 10 should be made and the indications then drawn on the plan. It should be remembered that one is drawing ideas, and not lines, and that the more ideas one has regarding the pantry, the better will be the indications of the pantry on the plan.

47. Kitchen.—The purpose of a kitchen is the preparation and cooking of food. It is necessary, therefore, that it contain a stove for cooking, a sink for washing and preparing vegetables, etc., and for washing dishes and cooking utensils. A dresser should be installed to contain cooking utensils, kitchen crockery, and some of the less bulky food supplies. There should be an ample closet in which to store the more bulky food supplies and kitchen utensils, preserves, etc. A refrigerator should be located so as to be convenient. All these features may next be drawn in place, using the blueprint as a model. Where a servants' dining room cannot be provided, the servants eat in the kitchen and a suitable place must be given for table and chairs. In the First-Floor Plan the table would be placed under the high window in the east wall of the kitchen.

48. The kitchen sink is located near a window so that there will be plenty of light to show when the utensils and dishes are properly cleaned. The sink is also close to the soil pipe which comes from the bathroom above. The sink should be drawn according to the indications shown in Part 1 of this paper and it should be of the size given on the plan.

49. A dresser is shown at *j* in the First-Floor Plan and is also shown in scale detail in *Architectural Drawing*, Part 1. Reference should be made to this detail so that the idea will be thoroughly understood that is to be indicated on this plan.

50. A closet in connection with the kitchen is almost indispensable. It is convenient for holding provisions, preserves, pots and pans, and other necessities. In this closet are shown shelves of different widths. Shelves can also be provided over the refrigerator. If so desired, the upper shelves can be enclosed by closet doors and fitted with locks and keys, thus affording excellent places to store preserves. Shelves are indicated by single lines and the word *shelves*. If doors are placed in front of the shelves, the doors are shown in the same manner as the doors of dressers.

51. An ice box or refrigerator is built into this closet and can be supplied with ice from the outside through a special door opening on the servants' porch. The ice man does not have to enter the house with a cake of dripping ice, when a built-in refrigerator is provided. The indication for the ice box is a rectangle showing the probable size of the ice box or refrigerator. The exact size of the refrigerator will be specified and need not be shown exactly.

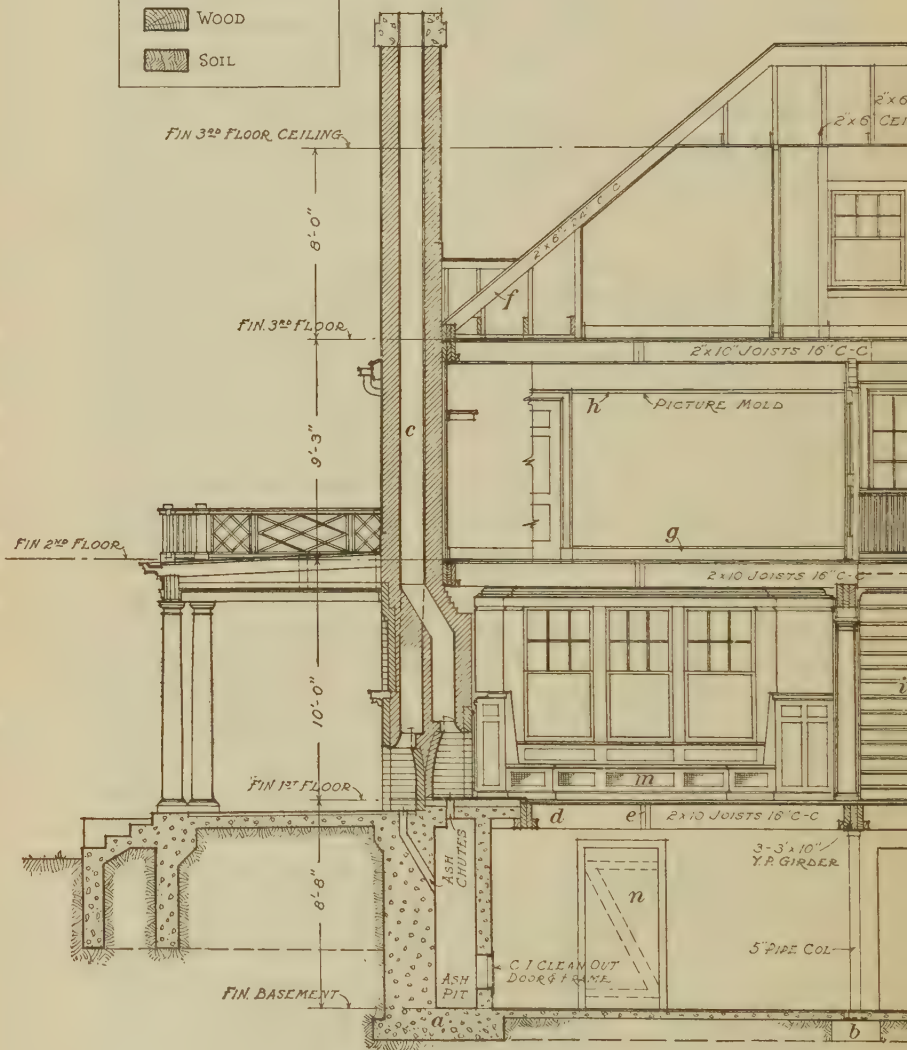
52. Space is provided on the west side of the kitchen for a table which is lighted by windows that are placed high in the wall so that the table can be placed against the wall.

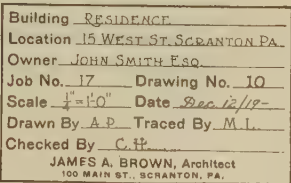
53. The stove shown is marked *Comb. Range*, which indicates a combination gas and coal range. This range sets on a concrete hearth which is shown by the outer rectangle. At the back of this range is a brick wall which cannot be set

LONGITUDINAL SECTION ON LINE C-D

ONE EIGHTH INCH SCALE

KEY	
	CONCRETE
	BRICK
	WOOD
	SOIL





JAMES A. BROWN, Architect
100 MAIN ST., SCRANTON, PA.

on fire by the heat from the range. A sheet-metal hood is to be placed over the range as indicated by the words *Hood Over*. The size and design of the range is specified. The approximate size should be known by the draftsman so that he may provide a hearth of sufficient size to support the range.

54. The chimney has two flues. One of them, *L*, is from the laundry in the basement and the second, *K*, is for the kitchen range. The smoke pipe from the range enters this flue from the side as shown by the broken line. Above this pipe an opening is built into the chimney and covered with a register. Through this register the cooking odors pass and go up the flue that is shown beside the kitchen flue. This flue is not lined and the heat from the kitchen flue tends to create a suction in it which will draw the odors up the chimney. A circle marked *F* indicates an outlet for fuel gas which is to supply the range.

55. A circle containing the marks *60 Gal.* represents a boiler for heating water for the various plumbing fixtures. This boiler is generally connected with the coal range, but may also be fitted with a special form of gas heater so that the water can be heated when there is no coal fire.

All these indications can be drawn in by scaling the sizes from the prints. The explanations are given so that the purposes of all parts will be understood and they can be intelligently drawn.

56. Service Porch.—A service porch is a necessity in a well-planned house. It affords a place for the servants to sit in pleasant weather. It also gives protection from rain and snow to tradesmen and others who may come to the kitchen entrance. This porch can be enclosed with mosquito screens, including a screen door, if it is found desirable to do so. The drawing consists of indicating the five square posts and the railing in between; it also includes the making of the steps, railing, and newels. In drawing this porch the East and North elevations should be referred to for the design of the posts, steps, and railings.

57. Breakfast Porch.—The breakfast porch may be used as a place in which to have breakfast or lunch, as well as a pleasant place in which to sit, work, or read. It is enclosed largely by glass, thus making it light and cheerful. Window boxes for holding plants are placed outside the windows on two sides, and the windows are casements, opening outwards. Potted plants can be placed on the tile floor, and the porch can be given the effect of a conservatory. The tile floor is of a quarry pattern, or in squares. A cement floor may be made and marked off in squares and colored to have an effect similar to a tile floor.

58. The exterior of this porch is designed with a pilaster treatment. The pilasters are arranged to correspond with the columns on the west porch, as will be seen in the South Elevation. This is done to produce the symmetrical effect already described. An outside entrance with steps and cheeks formed of concrete is provided for this porch. In drawing this porch the detail of the porch given in *Architectural Drawing*, Part 1, should be consulted.

59. The windows and doors between the breakfast porch and the dining room are designed to produce an open effect between these rooms, as well as to afford an attractive view from the dining room. This view is also obtained from the hall and the living room.

60. These effects are desired by the architect and are intended to make the house appear ample in size and interesting in appearance. A person entering the house from the vestibule will, no matter which way he looks, obtain an impression of roominess and elegance. If he looks into the living room he will see an ample, well-designed room. Looking through the dining room, an interesting view of the dining room and breakfast room is obtained. These ideas are what the architect is building and the drawing is made to crystallize these ideas. The draftsman should, therefore, feel that he is drawing ideas rather than making a nice arrangement of lines. The lines are merely the result of the ideas and they are of no use unless they express ideas.

61. Dining Room.—The symmetrical design of this room has been described under the heading of Symmetry and no difficulty should be experienced in completing this room. The axes in both directions should be drawn and the features in the various walls laid out with reference to them. The closet in connection with the dining room is a useful place in which to keep a silver safe, spare table linen, china, glass, and various articles that are used in connection with a dining room. All that is necessary to indicate is the closet itself. It will be seen in the longitudinal Section *CD* that the door to this closet and to the pantry are of the same design and are symmetrical with reference to the axis *UV*.

62. Vestibule.—The vestibule is designed to prevent the weather from beating into the house when the front door is opened. It has a tile floor, and the doors have side lights on each side. The effect of the vestibule should be in keeping with the character of the principal rooms of the house and it is generally designed to be attractive. The square tiles should be drawn so that they are all equal in size and exactly fill the space.

63. The Hall.—The hall should be ample so that several visitors can enter at once and not be crowded. A coat closet is provided to take care of wraps, umbrellas, overshoes, etc. This closet is placed back of the pantry. It is illuminated by a light in the ceiling which is turned on automatically by opening the door, and the light is extinguished by closing the door. To avoid the necessity of people going upstairs a toilet is provided under the stairs. The student should have no difficulty in drawing the indications of the basin, water closet, and side outlet shown here.

64. The door at the rear of the hall permits a servant, in answering the door bell, to go from the kitchen to the front door without going through the dining room where the family and guests may be assembled.

65. Stairs.—More mistakes are made in the drawing and arranging of stairs than in any other part of the building. It

is, therefore, very important that the stairs be designed so as to fit into the building and also that it can be determined from inspection whether sufficient space has been allowed for them. This space should be sufficient to accommodate a series of steps of such size as to be comfortable for regular use. It should be arranged so that the distance between any step and the construction above will be sufficient so that an adult walking up or down the stairs will not come in contact with the overhead construction. The stairway should be of sufficient

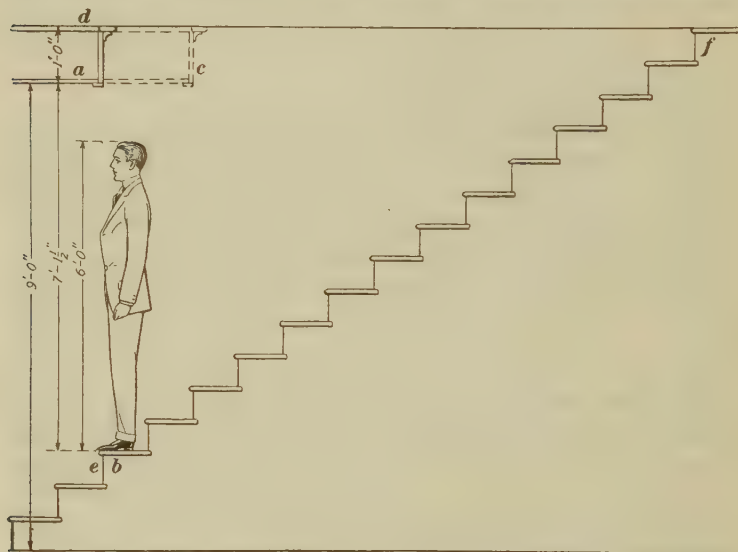


FIG. 11

size so that furniture may be conveyed up or down the stairs. This is impossible where there are sharp turns or very high balustrades and newels. It is also essential in placing closets beneath the stairs as shown under the stairs on the blueprint of the First-Floor Plan, that sufficient headroom be provided in the closet for its purpose.

66. Headroom.—The distance between the steps and the construction directly over them is known as *headroom*, and should not be less than 7 feet. The subject of headroom is illustrated in Fig. 11, in which a flight of stairs is shown in sec-

ONE EIGHTH. INCH SCALE



9:00

FIN 3RD FLOOR

2-3"

FIN. 2ND FLOOR

0-0"

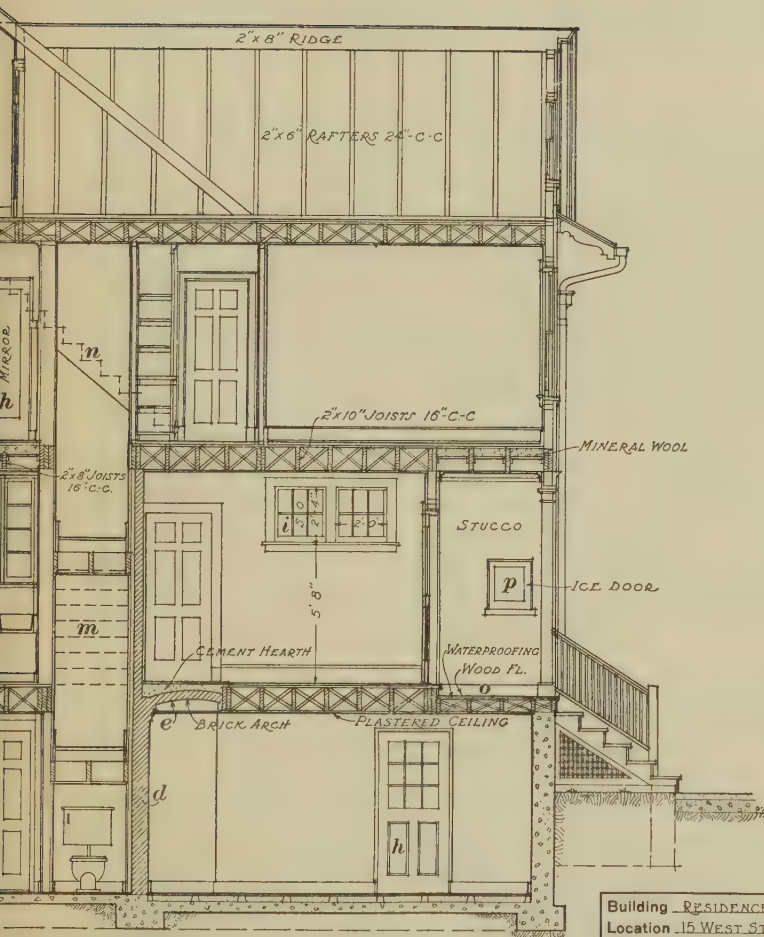
FIN. 1ST FLOOR

88

FIN BASEMENT LEVEL

PLASTERED CEILING

PLASTERED CEILIN



Building RESIDENCE
 Location 15 WEST ST. SCRANTON PA.
 Owner JOHN SMITH ESQ.
 Job No. 17 Drawing No. 9
 Scale $\frac{1}{4}'' = 1'-0''$ Date Dec. 12/17-
 Drawn By A.P. Traced By M.I.
 Checked By C.H.

JAMES A. BROWN, Architect
 100 MAIN ST., SCRANTON, PA.

tion, with the floor construction *a* extending over the lower steps of the flight. At no point should the headroom be less than 7 feet. If the construction *a* were to extend further over the stairs below, as at *c*, it would be impossible for a person to walk up or down these stairs without stooping or striking his head against the construction above.

It will be seen in this figure that if the ceiling height is 9 feet 0 inches the stairs cannot be extended more than three risers under the header *a* before the minimum headroom is reached.

67. The position at which the minimum headroom will occur can also be determined by counting down from the second-floor level to the riser *e*. Thus, the header *a* should be placed at such a distance from the top riser *f* that there will be 7 feet between the header *a* and the tread *b* directly below it. The number of risers necessary to obtain this headroom will depend on the height of the individual riser. This number may be found by the following rule: To the proper headroom, 7 feet, add the thickness of the floor construction (as at *a*) and divide this sum by the height of one riser. This will give the number of risers from the second floor to the top of the riser *e* in Fig. 11. By counting the risers in the illustration it will be found that *e* is the fourteenth riser down from the top. If the stairs are made somewhat steeper, this number can be reduced to 13 risers and the stairs will be comfortable. If, however, less than 13 risers are shown between the top riser and the header *a*, the headroom should be carefully checked up.

68. In the Second-Floor Plan on the main stairs exactly 13 risers are shown in the above position where the staircase will have about 7 feet headroom, which is sufficient.

69. In a case such as occurs in the rear stairs on the First-Floor Plan, one flight goes up directly over another. These stairs are generally steeper than the main stairs. If the sum of the risers going up, as at *m*, plus the sum of the risers going down, as at *l*, equals 13 at any riser, there will be enough headroom, provided that the riser is about 8 inches in height.

70. Number of Treads and Risers.—The number of risers for any flight, as well as the height of the riser, is determined in the following manner: It is assumed that the height of the story from floor to floor is 10 feet 5 inches, and it is desired to have a rise approximately $7\frac{1}{2}$ inches in height. The height of the story, 10 feet 5 inches, or 125 inches, is then divided by $7\frac{1}{2}$ inches and the result is found to be $16\frac{2}{3}$. This would mean that $16\frac{2}{3}$ risers of this height would be required. As it is obviously impossible to use $\frac{2}{3}$ of a riser, either 17 risers or 16 risers of equal height must be used. Dividing the story height, or 125 inches, by 16, gives 7.81. In other words, if 16 risers are used, each riser will be 7.81 inches or, practically, $7\frac{1}{4}$ inches in height. If it is decided to use 17 risers, $125 \div 17 = 7.35$ inches, or practically $7\frac{3}{8}$ inches.

The foregoing process may be stated in the form of a rule as follows: Assume a convenient height for the riser and divide the height of the story from floor to floor by the height of this riser. The result will generally be a number and a fraction. Divide the height of the story by the nearest whole number and the exact height of the riser will be obtained.

71. Indication of Stairs.—Stairs are indicated on plans as shown in the blueprints of Floor Plans, Elevations, and Sections. The main stairs for this building are shown in detail in *Architectural Drawing, Part 1*.

72. The draftsman should check up by simple calculations the amount of headroom that occurs beneath a run of stairs at any point. For example, the height of each riser in the main stairs is about $7\frac{1}{2}$ inches. The back of the closet is under the tenth riser. The height of the tread over the tenth riser is $10 \times 7\frac{1}{2}$ inches, or 75 inches, or 6 feet 3 inches. The construction of the stairs in this case will be about 15 inches in a vertical direction, thus leaving $75 \text{ inches} - 15 \text{ inches} = 60 \text{ inches}$ of clear vertical space at the wall at the back of the closet. This height is sufficient for a person seated. The height of the under side of the stairs at the front of the water closet will be at least 2 risers more, or 15 inches, thus making 75 inches or 6 feet 3 inches, which in the case shown is sufficient.

73. The stairs to the cellar and those to the second floor over these present another case where the draftsman by a simple calculation can make sure that the headroom has been properly assumed.

Take any point such as the top of the eighth riser on the stairs leading to the second story. This point is 8 risers above the first-floor level and the point below it is the top of the sixth riser below the first-floor level. Hence, there is a distance between these stairs at this point of $8+5=13$ risers. Assuming each riser to be about 8 inches in height the height in inches between the stairs at this point is 13×8 inches = 104 inches. Allowing about 15 inches for the thickness of the stair construction, the net distance between the stairs at this point is $104-15=7$ feet 5 inches, which is sufficient headroom. In drawing out stairs the draftsman should be very careful to see to it that there will be no difficulty regarding headroom.

74. The stairs are generally marked with numbers beginning with 1 at the bottom step. Arrows with the words *Up* or *Down* and the number of risers to the next floor are also placed at the tops and bottoms of the steps.

75. Staircases, their arrangement, and construction in all accessible buildings should be examined. In the house in which one is living, or in the building in which one is working, there are stairs. By carefully examining them, and measuring the various parts, such as the risers and treads, a person will soon become familiar with their characteristics and this practice will help immensely in working out the drawing exercises.

76. Living Room.—The living room, as it appears on the plan, is a matter of walls, all of which have been drawn. The fireplace forms the most conspicuous feature of this room on the plans and instructions regarding this have been given in *Architectural Drawing*, Part 1. Bookcases are indicated by suitable rectangles. When these cases are thus indicated, it is intended that they are to be built in place. The seat is also built in solid and contains a radiator. The front of the

seat contains a grille or register, and the top of the seat is hinged. It can be raised and the radiator reached for repairs.

It has been pointed out that three of the walls of the living room have been designed in plan so as to be symmetrical with regard to the axes of the room. The treatment of the walls must be designed on elevations at a scale, such as $\frac{3}{4}$ inch to the foot. On these elevations the trim of doors, windows, and openings to hall, also the fireplace, bookcases, and bay windows, are drawn out as the architect wishes to have them.

77. The Side Porch.—In drawing the side porch, first lay off the outside lines around the three sides. Then draw a faint line 9 inches inside the outside lines. On this line are the centers of the columns. Measure off the points on this line at which the centers of the columns are to be and after all the centers are located, draw three circles from each center. The inner circle should be drawn with a stronger line than the outer ones, as this represents the actual column. The outer circles represent the base moldings. Draw rectangles tangent to the outer circles as shown. These represent the base blocks of the columns. The lines showing the tiles of the finished floor are next drawn, also the steps to the grade.

78. Fireplaces.—The side porch has been provided with a fireplace. It is intended that a removable glass enclosure shall be provided for closing in this porch in cold weather and making an outside living room of it. When so used, a fireplace will serve to warm the porch.

In drawing this fireplace the various dimensions given should be laid off on the drawing. Where dimensions are not given, measurements should be taken from the blueprints and laid out on the drawing. The fireplace and the chimney breast should be symmetrical with respect to the axis CC' . A line 4 inches inside the outer line of the fireplace and chimney breast, should be drawn to represent a veneering of face brick with which the construction is covered. The circles marked F indicate fuel gas, which is brought to both the fireplaces.

79. Light Indications.—Certain symbols have been adopted by the National Contractors Association and the Amer-

ican Institute of Architects to indicate light outlets, switches, telephones, and various electric conveniences. The architect uses these symbols in his plans and they have a specific meaning to the electrical contractor. The symbols most commonly used in drawings to indicate electric outlets are shown in Fig. 12. Most of these symbols are used on the First-Floor Plan.

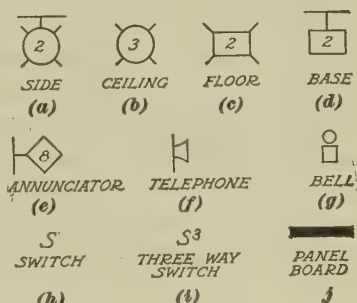


FIG. 12

In Fig. 12 at (a) is an indication of a side outlet which is situated on a wall about 5 or 6 feet above the floor to receive a wall bracket light. At (b) is an indication of an outlet for a ceiling light, at (c) for a floor outlet for lighting and at (d) for a base outlet. The numbers indicate the number of lights.

At (e) is an indication for an annunciator which shows which of several bells has been rung and is generally placed where the servants can see it. Annunciators are always used in hotels and sometimes in large residences. The figure 8 indicates that the annunciator responds to eight push buttons located at different parts of the house. When telephones are connected with the house, the receiver is indicated on plans as shown at (f). An indication of a door bell or other bell is shown at (g).

Switches are very convenient for turning lights on or off and where they are used they are generally indicated on the plans, by the use of the symbols *S* as shown at (h). Where a group of two or more switches is used this group is marked S^{II} , S^{III} , etc., according to the number of switches at that point.

A three-way switch is indicated as at (i) and a panel board is shown as at (j).



FIG. 13

80. Outlets.—Where gas and electricity are brought out at the same outlet, this is indicated for a wall outlet at (a), Fig. 13, and for a ceiling outlet at (b). The marks 3*E* and 2*G* show that the outlet

is for three electric lamps and two gas jets. Three gas outlets are shown in Fig. 14 for lighting, also three similar outlets for fuel gas.

81. Electrical Indications on the Plan.—In the dining room is shown a ceiling outlet indicating four lamps, each of which is the equivalent of one 50-watt lamp. Each of these outlets will safely supply a 25-watt or a 40-watt tungsten lamp. Two brackets or side outlets are shown, each for two 50-watt lamps. Two switches are placed at the entrance to the room, one to light one lamp and the other to light the remaining lamps.

82. In the breakfast porch a ceiling outlet and two base outlets are provided. The base outlets are to take floor lamps which can be connected by cords and sockets which are attached to the lamps as shown in Fig. 15, or to lamps that are supported on tables. A switch is placed in the dining room which will operate one lamp in the breakfast porch and another switch is placed inside the breakfast porch to operate the remainder of the lamps.

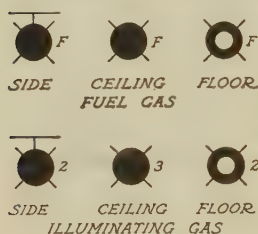


FIG. 14

83. In the hall, next to the vestibule door, are two switches. One of these marked *S* is to control the ceiling outlet in the vestibule; the other marked *S*³ is a three-way switch. This switch controls one lamp in the hall and one light in the second-floor hall. These two lamps are also controlled through a switch in the second-floor hall. A person coming home late in the evening can, upon entering the house, push the switch at the vestibule door and light up the lower hall and the second-floor hall so that he can see his way to the bedroom door and, by pushing another switch at the bedroom door, he can extinguish the lights in both halls.

84. A telephone outlet is shown on the east wall of the hall. A switch for operating the light on the rear porch is shown at the rear door.

85. In the kitchen is a switch for the kitchen lights; also a bell that is rung from the different doors or from push buttons in the family rooms. The annunciator shows which button has been pushed.

A switch is placed at the head of the basement stairs in the pantry. This is marked S^3 to *Basement* and is a three-way switch. By pushing this switch the light in the basement lights the stairs. This light can be turned off by the switch in the basement if desired.

A three-way switch is installed in connection with the service stairs which is operated at the switch marked S^3 and lights one lamp at the head of the stairs in the second and attic floors. These lights can be turned off at any floor. Thus, a servant leaving the kitchen can turn on lights which will light up both flights of stairs, and upon reaching the second floor or the attic can turn them off.

All the electric indications should be shown on the First-Floor Plan, following the models given in the blueprint.

86. Plumbing Indications.—The student should be able to draw neatly the plumbing fixtures shown in this plan, making them like the indications drawn on Plate I, *Architectural Drawing*, Part 1. There are two sinks, one water closet, and one wash basin shown on this plan.

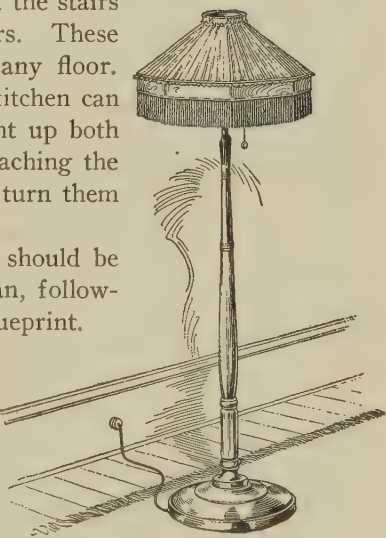


FIG. 15

87. Joist Indications.—The architect rarely makes framing plans for small buildings, but should give information regarding the direction in which the floor joists run. This is often done as shown on the First-Floor Plan by a line with arrowheads indicating the direction in which the joists run. Over this line is marked the sizes of the beams and the distance

on centers that they are spaced. The actual working out of the framing plan is left to the carpenter contractor. Nevertheless, the architect should be competent to lay out the framing plan and is responsible to the owner for the proper construction of the building. The indications for the floor joists should be drawn in and neatly lettered.

88. Dimensions.—The dimensions should be carefully shown on the plans. This will save trouble and errors in erecting the building. In dimensioning the present plan, the principal figures have been given from the outside face of the stucco. Thus, the left-hand, or west, wall is 30 feet in length, the front wall 44 feet in length. These general dimensions are subdivided into smaller ones which locate the details of the outer wall. The west wall, 30 feet in length, is divided into three dimensions—11 feet, 8 feet, and 11 feet—thus locating the chimney. Another line of dimension locates the French windows and the fireplace and shows the $2\frac{1}{2}$ -inch distance between the face of the stucco and the face of the stud. Having the distances from the studs, the windows and fireplace can be laid out before the outside plastering is begun.

89. Where the windows are to be placed symmetrically with reference to the axis of the room, the dimensions locating the windows must be carefully calculated so that the windows will be so placed. The dining-room windows are symmetrical with the axis UV . The width of the dining room is 16 feet 6 inches, less 1 inch + 5 inches, which is 16 feet. The axis UV is, therefore, 8 feet from the inside of the east wall, or 8 feet + $7\frac{1}{2}$ inches from the outside of the wall. The axis of the right-hand window of the dining room is 4 feet less than this from the outside of the east wall, or 4 feet $7\frac{1}{2}$ inches. This is shown by the two dimensions $2\frac{1}{2}$ inches and 4 feet 5 inches on the plan.

90. The distance between the axes AA' and UV on the outside and inside lines of dimensions should be equal. On the inside line this distance is 4 feet 6 inches + $9\frac{1}{2}$ inches + 1 inch + 8 feet (one-half the width of the dining room) = 13 feet $4\frac{1}{2}$ inches. The corresponding exterior measurements are

9 feet $4\frac{1}{2}$ inches + 4 feet = 13 feet $4\frac{1}{2}$ inches. The dimensions on the left half of the front must be the same as those on the right half, only reversed. The distance from the outside of the west wall to the axis WX of the living room must be $2\frac{1}{2}$ inches + 4 feet 5 inches + 4 feet = 8 feet $7\frac{1}{2}$ inches. At the front are found the figures $2\frac{1}{2}$ inches + 4 feet 5 inches + 4 feet = 8 feet $7\frac{1}{2}$ inches. At the rear, the corresponding figures are $2\frac{1}{2}$ inches + 2 feet 2 inches + 6 feet 3 inches = 8 feet $7\frac{1}{2}$ inches.

91. Windows and outside doors in frame walls are generally located by the center lines. The completed window frame is brought to the building, its center marked, and it is set with reference to this center. The windows in the frame walls of this building are, therefore, located by giving the dimensions to their centers.

92. The dimensions of the porches are generally omitted on the quarter-scale drawings and are obtained from large-scale drawings from which the porches are built.

93. Dimensions of all brickwork should be carefully given, as the framing depends upon this. The main dimensions of the chimneys are shown on this plan. Details of the chimneys at a large scale are usually prepared from which the chimneys and fireplaces are erected.

94. Partitions are generally measured to their centers when they are ordinary partitions about 6 inches thick. Partitions thicker than this can be built by using 6-inch studding for 8-inch partitions. For thicker partitions two rows of 4-inch studs may be used. The dimensions to the outside of the studding should be given as shown in the partition between the hall and the living room.

95. Dimensions and dimension lines showing the distances intended to be covered by the dimensions should be drawn as shown. An arrowhead should be drawn at each end of the dimension line showing the distance covered.

96. Lettering.—The plans should be neatly lettered as shown on the blueprint. The names of the various rooms should

be placed as near the middle of the rooms as possible. The other lettering should be as close as possible to the object referred to. The lettering should be placed so as to not crowd or conceal the figures, or indications, so that it can be easily seen.

97. Final Tracing.—The drawing of the First-Floor Plan is left on the board and a fresh sheet of tracing paper is tacked down on top of it. The first drawing of the First-Floor Plan will probably not be clean and neat. A neat, clean tracing should, therefore, be made of it on the new sheet of tracing paper. Parts of the first drawing which have not been done satisfactorily may be redrawn carefully on this second sheet and the work that is satisfactory may be traced through very quickly. This will be a valuable exercise and will result in a neat, clean piece of work. When a satisfactory tracing in pencil has been completed, it should be dimensioned and



FIG. 16

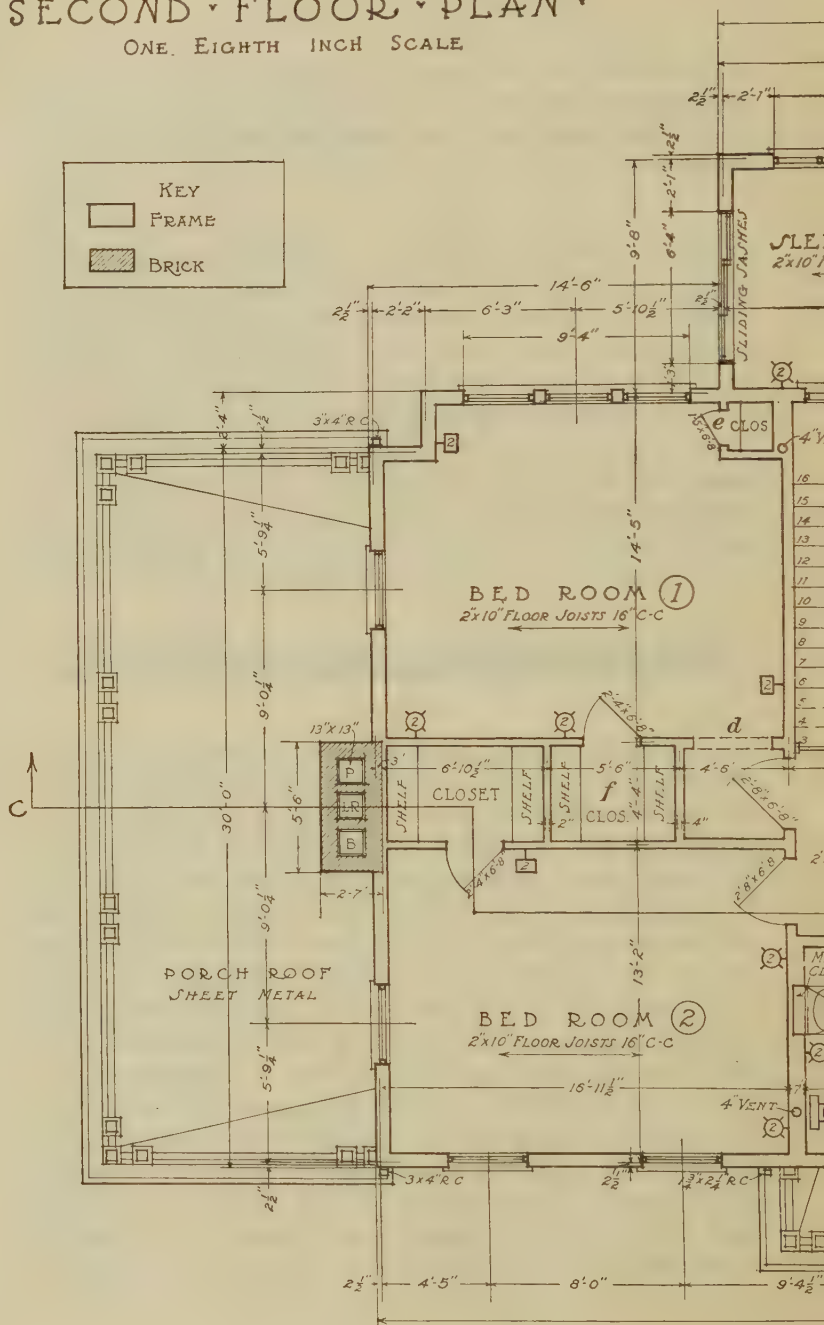
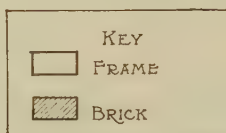
lettered. The blueprints will serve as a model for this work.

After this tracing is completed, it should be traced in ink upon tracing cloth, as is done in most architect's offices. The outlines of the walls, partitions, and other supports should be made in firm, heavy lines; the windows, areas, steps, and other parts in a lighter line. The dimension lines should be made lightest of all. Send both the pencil tracing and the tracing on cloth to the Schools for correction, as the percentage will be determined by the work on both drawings.

The following method is a good one for always obtaining the same thickness of ink-line. Having set the nibs of the pen at a proper distance apart to produce a satisfactory line, make a scratch on the screw head *b*, as shown at *a*, Fig. 16. If the pen is opened for cleaning, it can always be set again with the line *a* in the same position and the same thickness of line obtained. If a thinner line is desired, turn the screw head sufficiently to make such a line, and note where the line *a*

• SECOND • FLOOR • PLAN •

ONE EIGHTH INCH SCALE



points, as at *c* for instance. This thickness of line can always be obtained by turning the head until the line points as at *c*. Three thicknesses of lines are called for in Plate I. The thickest lines may be obtained with the scratch at *a*, the medium lines with the scratch at *c*, and the thinnest lines with the scratch at *d*. The position of these lines may not be exactly as shown in the figure, but must be determined by the learner, who will thus remember just where to have the scratch to produce the various lines.

PLATE II, TITLE: SECOND-FLOOR PLAN

98. General.—A third sheet of tracing paper can next be tacked down over the first two, and some of the walls, partitions, and center lines of windows can be traced through directly, thus saving a lot of time which might be lost if the Second-Floor Plan had to be drawn upon another board.

The instructions given for drawing this plan are similar to those already given for the First-Floor Plan, and there should be little or no difficulty in laying out the various parts of this plan.

The axes, or center lines, of the various windows should, in most cases, come directly above the axes of the windows below. This can be verified by the figures on both plans or by studying the elevations. In some cases it is impossible to place the windows directly over the ones below, as in the rear hall and the servants' bathroom. In this case, however, the kitchen window group below is centered between the two windows above. This gives a restful and artistic result and shows careful design.

The features that should be observed and kept in mind while drawing out the ideas in this plan, will next be described.

99. Bedrooms.—It will be observed that all the bedrooms are rectangular, of good size, well lighted by sufficient windows, and that each one has at least one good closet. The owner's room, No. 3, has two closets and a private bath in which there is a third closet. In this room the best position for the bed or beds will be against the private bathroom wall. The space for

the bureau or dressing table is against the left-hand wall, where a wall bracket is provided on each side for light. Convenient wall spaces against which chiffoniers, dressing tables, or chairs can be placed are provided. A base outlet is provided near the place where the bed is to go, so that a light may be available for a table at the head of the bed.

A careful study of bedrooms numbered 1 and 2 will show a similar provision for beds, bureaus, etc., as well as for good closets.

100. Servant's Bedroom.—A servant's bedroom is shown in the kitchen wing, and is entered from the rear hall, which is closed off from the hall proper by a door.

101. Sleeping Porch.—A sleeping porch is provided at the rear of the hall. This porch is to contain beds only and the bedrooms will be used as dressing rooms.

102. Stairs.—The main stairs are shown. The floor opening that must be left over them to provide sufficient headroom should be carefully calculated. In this case a person will have descended 13 risers before he will be below the floor level. As the risers are about $7\frac{1}{2}$ inches, the distance between the second floor and the thirteenth tread is $13 \times 7\frac{1}{2}$ inches = $97\frac{1}{2}$ inches. The thickness of the floor construction, about 12 inches, should be deducted from the $97\frac{1}{2}$ inches and the resulting clear headroom will be $97\frac{1}{2}$ inches - 12 inches = $85\frac{1}{2}$ inches, or 7 feet $1\frac{1}{2}$ inches. This is about as small an allowance as should be made. The draftsman should be extremely particular about this matter of headroom on stairs, as an error in this matter, if not discovered in time, may cause serious difficulty in remedying mistakes after the building is well advanced.

103. Considering the rear stairs leading down to the kitchen, it will be seen that a person will have descended 13 risers before meeting any construction above and, according to the calculations made above, there will be sufficient headroom for a person using these stairs. A flight of stairs leading from the rear hall up to the third, or attic, floor is provided.

ONE EIGHTH INCH SCALE





Building RESIDENCE
 Location 15 WEST ST. SCRANTON PA.
 Owner JOHN SMITH, ESQ.
 Job No. 17 Drawing No. 1
 Scale 1/4" = 1'-0" Date Dec. 12/18-
 Drawn By A.P. Traced By M.L.
 Checked By C.H.
 JAMES A. BROWN, Architect
 100 MAIN ST., SCRANTON, PA.

An inspection of these stairs on the attic plan will show whether these is sufficient headroom.

A wise precaution is illustrated on the East Elevation and in the Longitudinal Section. The service stairs have been carefully located on these drawings so that the draftsman can check up their relations to each other and to the surrounding construction, and thus prevent errors in their design.

104. Bathrooms.—The arrangement of the fixtures in bathrooms depends upon the location of the soil pipes. Low fixtures such as water closets should be placed as close to the soil pipe as possible. The piping for these fixtures extends beneath the floor, and if it must be carried for any considerable distance in a longitudinal direction, it will stick out below the ceiling. The bathtubs also have the pipes below the floor, and it is desirable that the wastes from them should be as close to the soil pipe as possible. The waste pipe from the wash basin is higher and can be carried for some distance in a horizontal direction without projecting below the ceiling beneath. In the servants' bathroom the arrangement is very good. In the owner's bathroom the arrangement is practical as the waste pipe from the bathtub can be carried across on the pantry ceiling if necessary. In the general bathroom the water closet is close to the soil line and the bathtub waste can be carried across successfully to the soil line between the floorbeams. These considerations are not apparent to the novice or layman, but these ideas should be incorporated in every drawing.

105. Chimneys.—As there are no fireplaces on this floor, all that will be necessary to do is to see that flues of sufficient sizes are provided to take care of everything below. Thus, in the kitchen chimney, a flue must be provided for the laundry and one for the kitchen range. These flues should be lined. An unlined flue must be provided to remove the odors from cooking.

The chimney over the living-room fireplace should contain three lined flues as indicated: one for the boiler in the cellar, one for the side porch, and one for the living room. In draw-

ing this chimney, it should be placed, in the Second-Floor Plan, so that it is properly supported on the chimney below, and is located in the center of the gable as shown on the West Elevation.

106. Porch Roofs.—The roofs of the porches are shown with sheet metal. These roofs must be designed so that water falling on them will run to the gutters. They must consequently have a slight pitch toward the leaders or conductors. Railings are shown on the roofs with newels over the columns or piers below. The bottom rails of these railings must be kept up 2 or 3 inches above the metal coverings, so that water can flow under them. This is shown on the elevation of the porches.

Make a clean tracing with pencil on tracing paper, also a tracing in ink upon cloth and send them to the Schools for correction

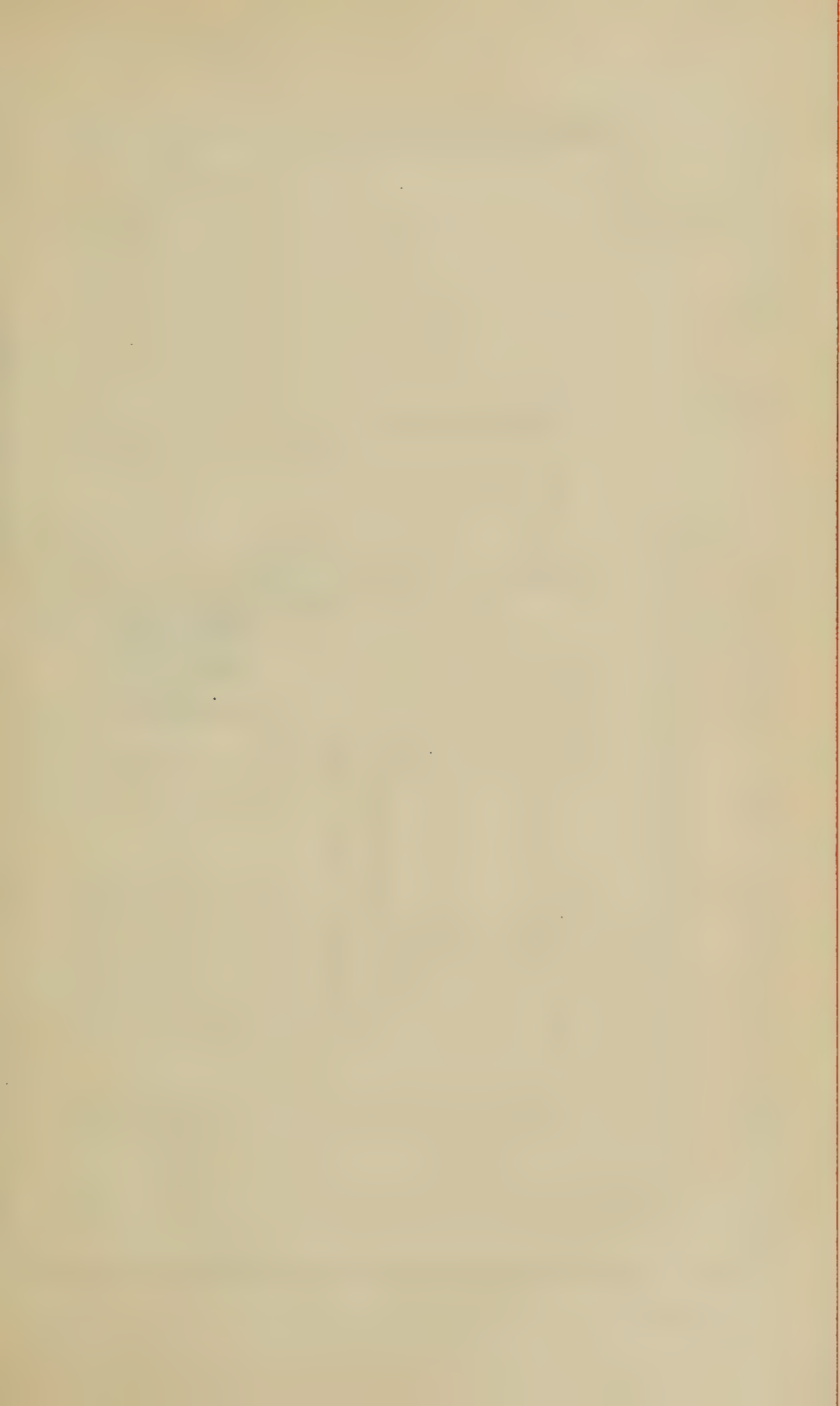
PLATE III, TITLE: SOUTH ELEVATION

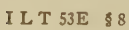
107. Blocking Out the Elevation.—A fresh sheet of tracing paper should now be tacked down and Plate III begun. This plate will be the South Elevation of the building shown in the blueprints. Having laid out the space 15 inches×20 inches, proceed to draw the lines as shown in Fig. 17.

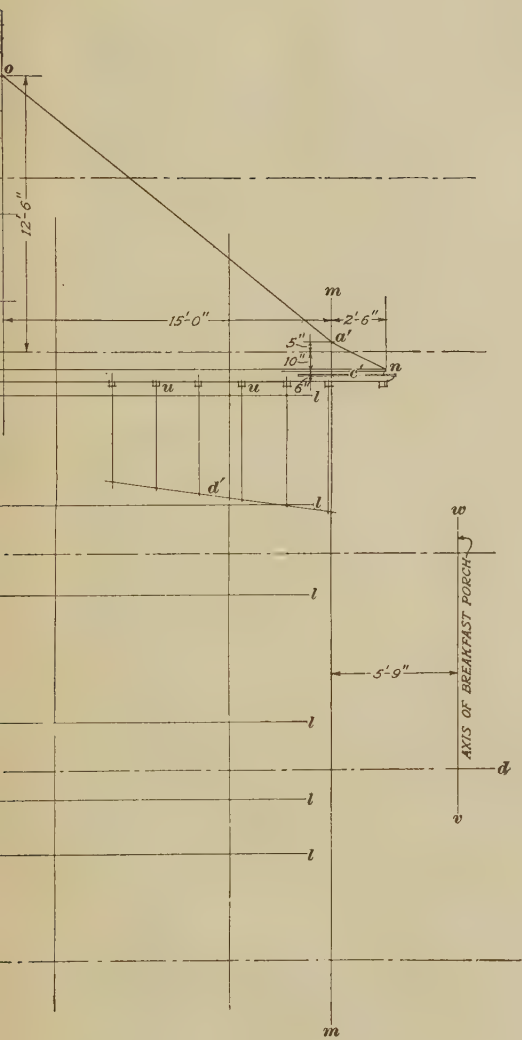
First draw a faint line *ab*, 10 inches from the left-side border line. This is the main axis of the building corresponding to the axis *AA'* on the plans. Measure up $4\frac{1}{4}$ inches from the bottom border line and draw a faint horizontal line *cd*. This is the level of the finished first floor and is so marked on the blueprint on the left-hand end of the print.

108. Story Heights.—Lay off the line *cf* of story heights. Beginning at the first-floor level, lay off the heights shown, making marks for the various floor levels. Through these marks draw floor lines across the elevation as shown on this plate. These lines may be made with dots and dashes as shown.

109. Windows.—Draw axis lines *gh* and *ij* of the windows. These lines are located on the First-Floor Plan by the







figures which locate these windows on this plan. Thus, ij , Fig. 17, is 9 feet $4\frac{1}{2}$ inches from the axis ab , and gh is 8 feet to the left of ij .

Draw the outside lines of the east and west walls, making them 22 feet from the axis ab . On the line gh lay off the heights of the window sills and heads above the floors as shown in the left-hand line of windows on the blueprint. When all the marks showing the levels of the window sills and heads are properly laid off, draw faint horizontal lines across the paper, as at kl , and thus locate the tops and bottoms of the window openings. These lines are to be drawn lightly so that the parts not used may be erased. The distances shown between the tops of the windows and the finished floor levels include the floor construction, which is 14 inches or 15 inches in thickness, thus leaving 9 inches or 10 inches between the tops of the window openings and the ceilings.

110. Roof.—The slope no of the roof is found as follows: Extend the outside line mm of the east wall upwards. At a point 5 inches above the *Fin. 3rd-Floor* line make a mark a' . Draw a line 15 feet to the left of the line mm and at a point on that line 12 feet 6 inches above the *Fin. 3rd-Floor* line make another mark o . Connect these marks, and this line will be the slope of the roof. Mark a point, n , 2 feet 6 inches to the right of the line mm on a horizontal line 10 inches below the *Fin. 3rd-Floor* line. Connect $a'n$ and the profile of the roof will be completed.

The Boston hips can then be drawn in as shown in the blueprint. After the dormers have been drawn in, the roof surface may be lined off to represent the shingle courses. The lines are about 4 inches apart on the elevation. Slate roofing is represented in a similar manner.

111. Dormer Windows.—Draw axes qr and st , making them 6 feet each side of the axis ab . On the Third-Floor Plan, these axes are shown 12 feet apart and symmetrical with the axis ab of the front. The height of the windows in the dormers is given in the South Elevation, and should be laid out as shown in Fig. 18.

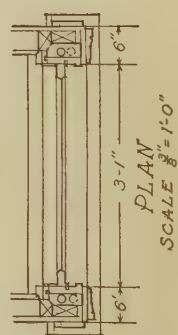
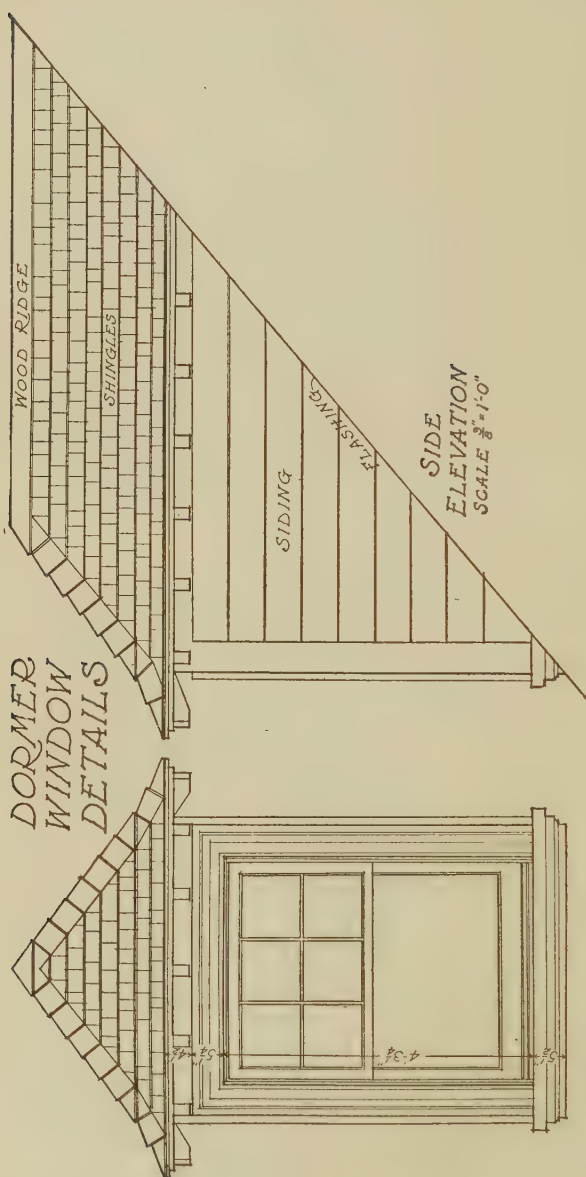
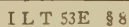


FIG. 18

KEY

 FRAME

 BRICK





112. Completing Windows.—In drawing the windows shown at the scale of $\frac{1}{4}$ inch to 1 foot where blinds are used, take one-half of the sash opening on the compasses and lay it off twice on each side of the center line as shown at b' in Fig. 17. The inside two parts will be the window opening and the outer two parts will represent the blinds. This should be done with all the windows, after which the sash and the slats in the blinds can be indicated. Refer to Fig. 27, *Architectural Drawing*, Part 1, for the detail of this window and obtain a clear understanding of this feature.

113. Cornice.—The cornice lines c' having been drawn, the brackets can be spaced as shown. The distance between the end brackets near p in the blueprint must be divided into equal spaces. The spacing can be done by the use of the method given in *Architectural Drawing*, Part 1, describing the use of the scale in dividing a line into any number of parts. Thus, the distance between the end brackets p in the blueprint is divided into 22 parts with 23 brackets. Take a 12-inch scale and place the 0 mark under the center of one end bracket, Fig. 17, and the 11-inch mark under the center of the other end bracket and point off every $\frac{1}{2}$ inch between as at d' , Fig. 17. Then draw with the T square and triangle vertical lines from the points to the place where the brackets are to go, as at u , and the lines will be the centers of the brackets. The size of the brackets may be scaled from the blueprints of the South Elevation and drawn in.

114. Porches.—The breakfast porch is shown at a large scale in *Architectural Drawing*, Part 1. This detail should be carefully studied, as it shows the finished sizes of the various parts and the way they are put together. In Fig. 37, Part 1, it will be found that the axis line of the window, shown on the First-Floor Plan as ZY , is 5 feet 6 inches to the right of the stucco face of the east wall of the building. This axis is drawn in at vw in Fig. 17, and the various features of the breakfast porch are drawn symmetrically to this axis. The quarter-scale drawings will not show all the moldings or small breaks in the surfaces, but should indicate all the essential parts

as shown on the First-Floor Plan and the South and East Elevations.

Having the scale details given in *Architectural Drawing*, Part 1, and the blueprints, there should be no difficulty in drawing these porches. Pieces of tracing paper can be tacked down, and two or three practice drawings made of these porches, after which they can be drawn finally on the elevation.

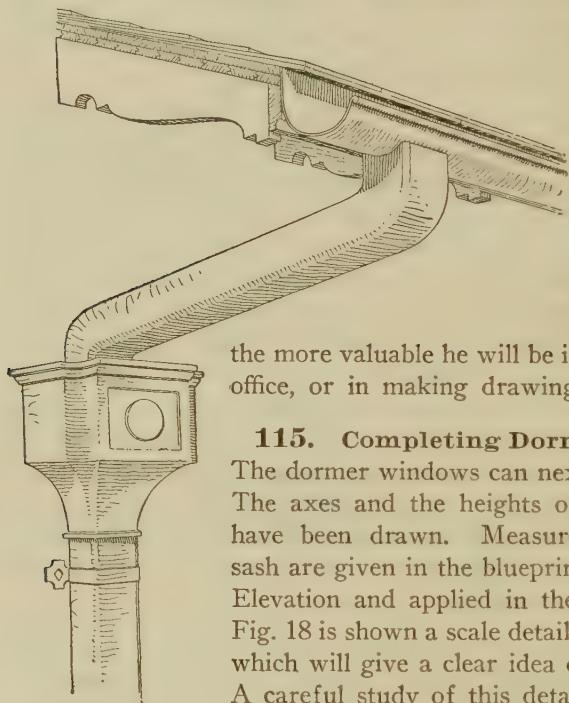


FIG. 19

Too much time cannot be spent in practicing and studying drawings of this kind. The better qualified a person is to do this kind of work,

the more valuable he will be in an architect's office, or in making drawings for himself.

115. Completing Dormer Window.

The dormer windows can next be drawn in. The axes and the heights of the windows have been drawn. Measurements of the sash are given in the blueprint of the South Elevation and applied in the drawing. In Fig. 18 is shown a scale detail of this dormer which will give a clear idea of this feature. A careful study of this detail should make it easy to finish the drawings of the dormer

windows in a satisfactory manner.

116. Rain Conductors.—Rain conductors, or leaders, should be shown at each end of the building extending from the gutter to the ground. These conductors are fitted with *goosenecks* *p* in the blueprint and conductor heads *q*. The conductor is fastened to the house by means of straps *r*. In Fig. 19 is given an isometric view of the upper part of a rain

conductor showing a gooseneck, a conductor head, a strap, and the conductor. These gutters, leaders, etc. are used on the South Elevation which is being drawn, and will illustrate the idea that is to be drawn out.

There are small rectangular conductors on the front entrance to drain the roof over the vestibule. The roofs of the breakfast porch and the side porch are drained into the conductors from the eaves gutter.

117. Chimneys.—The chimneys are located in the Attic Plan in the positions at which they project through the roof. The tops of the chimneys are generally carried up a short distance above the highest point of the roof, so that the roof will not interfere with the draft. They are provided with flashing and counterflashing, as indicated.

118. The **footings** *a* are drawn as shown with the top about 6 inches below the finished cellar floor. The footings shown on this elevation are 12 inches thick. If the soil is hard they may be made 8 inches thick, and a saving in cost can be made.

119. Flashings are shown where the chimneys meet the roof. These flashings are *stepped up* into the brickwork, that is, the metal is let into the brickwork where the joints occur.

120. The **shingles** are indicated on the main roof, the spaces between these lines being approximately equal to the lengths of the shingles as they show in the face of the roof. The treatment of the hips is known as the *Boston hip*. The ridge may be formed of boards or of galvanized iron.

121. Stucco is indicated by the use of dots which are made over parts of the stucco surface. The concrete face below the water-table is indicated in a similar manner. The specifications make clear which is stucco and which is concrete.

122. Having completed this tracing in pencil, make a new clean tracing upon tracing paper with pencil; also an ink tracing on cloth and send both to the Schools for inspection.

123. Final.—Drawings of two floor plans and one elevation of the set of plans are required and must be sent to the Schools for criticism. As a matter of experience and self-improvement, it is advisable to make drawings and tracings of the remaining plans, elevations, and sections shown in the blueprints. These drawings are not to be sent to the Schools. Making drawings and tracings of these drawings is the kind of work that is done in architects' offices and is required in taking examinations for State registration.

